NEWSLETTER

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International Union of Radioecology

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Newsletter 36

IUR General Assembly

IUR Generel Assembly was held in Keszthely, Hungary on 26th August.

Summary of the minutes from this meeting is presented on page 2.

New Editor of the IUR Newsletter

Steve Domotor, Senior Scientist within the U.S.Department of Energy (DOE) has accepted to take over as an editor for the IUR Newsletter. It is considered very important that also members from outside Europe are involved in the executive work of IUR and we wish him a warm welcome as Editor.

Stephen Domotor

currently serves as a senior scientist within the U.S. Department of Energy's (DOE) Office of Environmental Policy and Guidance, Washington, D.C. (USA). He has a broad range of responsibilities in radiation dose and risk assessment for ecological and human health protection, and develops Department-wide air, water, and radiation-related environmental protection standards, policies, and guidance. He currently chairs DOE's Biota Dose Assessment Committee, and serves as a senior advisor to DOE's program and field organizations regarding environmental surveillance and evaluation of radiation effects on biota and ecosystems. Previously within DOE, Mr. Domotor held a variety of science, risk, and policy positions, where he helped to establish and implement the Environmental Management Science Program, technology development programs to support waste management and environmental restoration operations, and environmental monitoring programs for DOE production reactors and facilities. Prior to DOE, he was an environmental radiochemist and Director of the radiation chemistry-radioecology laboratory for the Maryland Department of Natural Resources. Mr. Domotor holds a B.S. degree in Biology from St. Mary's College of Maryland (USA), and an M.S. degree in Marine-Estuarine-Environmental Science from the University of Maryland (USA), where he was awarded a Chesapeake Biological Laboratory research fellowship. He has conducted a variety of research and has numerous publications in the areas of: fate, transport, and effects of radionuclides in freshwater and estuarine systems, nutrient transport in marine-estuarine systems, phytoplankton physiology, and nutrient cycling in reef-building corals. He is currently a senior fellow in the Council for Excellence in Government (USA).

Herewith Gilbert Desmet steps aside as the Editor of the IUR Newsletter, as he judged that his responsibility of President should be rather not combined with the absorbing task of Editor. He prefers to fully spend his time to scientific management of the IUR and to his representative responsibilities! The President is to be thanked for the efforts he delivered and initiatives he took to make this IUR Newsletter more interactively used by the IUR Members.

As the President only now, he expresses his hope to see this Newsletter becoming increasingly a real forum of debate; he would also be happy to see the same coming about with the IUR Website! He welcomes the new Editor, dr. Stephen Domotor, and counts upon his dedication and courage to further improve the quality of our Newsletter and to maintain a fair balance in the representativity of the contributions by the IUR Members. This taking over of the editorial responsibility exemplifies the increasing international character of the IUR. The President wishes him much success in all his IUR endeavours, and a good collaboration with the other editorial members, and the IUR-Secretariat.

International Cooperation on Environmental Protection

IUR has taken initiatives for international co-ordination on the topic of protection of the environment from ionising radiation.

On June 19 and 20 a coordination meeting was held with the participation of IAEA, EU research programme FASSET and EPIC, and IUR. This was followed by a broader meeting on the 28 of August, in Vienna between IUR, IAEA, and AMAP and representatives of national programmes. In the same week, a IAEA specialists meeting on this topic was held, with participation from several parties including IUR. IUR has agreed to take responsibility for establishing a web site that will provide an overview of ongoing activities in this field. The address is: www.iur-uir.com/environment/biota.htm

Read more on page 8.

Financial Situation

The financial status for 1999 was presented at the General Assembly in Keszthely and shows that the economical situation of IUR has improved considerably the last year. The IUR membership fee for 2001 will not be increased.

Read more on page 4.

Minutes of the XXIII General Assembly of the International Union of Radioecology

in Keszthely, Saturday 26th August 2000

1. Report on the activities in 1999/2000.

The Moral Report by the President was presented. The text is presented in this Newsletter. The General Secretary reported on recent activities of the IUR in the past period including:

- The 4th International conference on Environmental Radioactivity in the Arctic in Edinburgh, Sept. 99 (including the last General Assembly), where the IUR was one of the organisers.
- The completion of the IUR/EULEP/EURADOS Concerted Action. All reports have now been sent to the Commission and all money due paid by the EC.
- IUR collaborations: ESNA, IAEA Biomass Programme – Fruit and Forest, AMAP – Arctic Council of 8 countries – IUR appointed as an observer
  Protection of the Environment issue has been promoted strongly
- Cooperation with Journal of Environmental Radioactivity established
- Importance of involving Asia and South America more strongly in IUR
- 88 new members have joined the IUR from 1.1.99 until 20.8.00.
- The proposals EPIC and FASSETT, which were an output of IUR Task Groups, have been accepted by the EC. These projects will give input to IUR activities on doses to biota.

2. Task Groups Status

The new IUR Task Groups were presented:

1. Priorities and Perspectives for Radioecology
2. Application of radioecological assets for Dose and Risk Assessment and other aspects of radiation protection
3. Exposure and Effects in Biota
4. Integrated Rehabilitation of Contaminated Areas
5. Natural radiation/T.E. NORM
6. Arctic and Antarctic Regions
7. Tropical Zones
8. Mediterranean /Fruit Peculiarities
9. Application of Radioecology to other Contaminants (AROC).

All members are also asked to develop their own initiatives and to indicate their interests for Task Groups to the IUR Board. All Task Groups are open for all IUR Members. Some participants pointed out that all members joining one of the Task Groups would have to make their own economic contribution besides their scientific contribution. In response, some limited funds have been allocated in the budget for some support to IUR members for task forces. However, it was acknowledged that the IUR represents a unique plat-form for meeting with colleagues and to enter into iindependent intellectual debates to the benefit of individual scientists and their respective organisations.

3. Contacts with other Scientific Societies, involved in environmental research.

There was a discussion on SETAC, and the idea to seek closer collaboration with this Society was supported. Initiatives in this direction will be taken, and reported to the Members of the IUR.

4. The IUR and the organisation of "regional branches": a reply to requests!

Upon the request of some participants the Executive Committee will work on a concept to enhance the participation of non-Western, especially non-European Members in the IUR activities and more contacts will be sought with these Members. The Executive Committee will work out a plan to facilitate the administrative interaction between the IUR Administration and the "regional branches".

5. Co-organisation of scientific meetings

- ECORAD 2001, IPSN, France, Sept 2001. A closer involvement of the IUR was suggested through the organisation of a Special Workshop during the conference.
- International Conference on Radioactivity in the Environment, Principality of Monaco, September 2002. IUR is one of the organisers and will give support. The "Abdus Salam International Centre for theoretical Physics" (ICTP) will organise a Conference at San Luis, Argentina where both radioecological problems and conventional ecological issues will be dealt with. The IUR will seek financial support, considering that the IUR strongly supports a close collaboration between areas of radioecology and conventional environmental research.
- Arctic and Antarctic Conference in St. Petersburg, June 2002. IUR is one of the organisers.
- Official participation of IUR in the "International Conference of 15 Years after Chernobyl", and neighbouring scientific activities!

- Joint organisation between IUR and SETAC of AROC meeting at Antwerp, Belgium, autumn 2001
- Joint organisation between SETAC and IUR of a "Rehabilitation Workshop" at the SETAC –Europe 11th Annual meeting, Madrid, Spain
- Involvement of the IUR in an ANPA organised project "SOILSAMP" where a harmonisation of soil sampling strategies will be established not only for radionuclides but also for non-nuclear pollutants. The IUR will receive financial support for this involvement.

6. Publications by IUR: IUR Newsletter; IUR Website; IUR scientific publications.

All IUR publications are now published in a common design, as well as the Web sites. The Newsletter will be published 3 times a year. For the last two issues of the Newsletter, the number of maximum pages (26) was easily reached. To be able to maintain the production and quality of the Newsletter, however, a continuous delivery of good input to the Newsletter is essential!
The production of Technical Documents will continue, reporting on scientific achievements under IUR auspices. Copies of the latest Technical Documents were distributed! They are available at the Secretariat!
The IUR Members are becoming increasingly aware of the existence of the revised IUR Website, which however could be more intensively and interactively used by all IUR Members!

7. IUR Project planning and Sponsorship by third parties.

It is foreseen in the Statutes of the IUR, to attract support from Institutes involved in research or activities relevant for radioecology. Support for this concept of Sustaining Memberships by Institutes has been actively solicited. Some institutes have already responded positively such as NRPA, (NO), SCK-CEN, (BE) and ANPA (IT).

8. Finances and budget

The financial status of the IUR and the Balance Sheet as of 31.12.99 were presented. It shows a total equity of 64.305,37 EURO. The Budget for 2001 was also presented. The financial situation of the IUR has improved considerably. There will be no increase in the IUR membership fee for 2001.
Details of these financial and budgetary statements are shown in the Treasurers' report in this Newsletter. No objections were received from the floor and the annual accounts were approved.

9. General Assembly 2001 and 2002.

The General Assembly for 2001 will be held in Aix-en-Provence and for 2002 suggestions were presented for the organisation of the General Assembly together with other important events such as at the ICTP Conference in San Luis, Argentina or at the Monaco Conference.

Report by the President

Radioecology today, is in the middle of the eye of hurr[redacted]with political and public interest and s[redacted] osci[redacted]p and down! The IUR as the organisat[redacted] exc[redacted] has the main task to r[redacted] ther[redacted] ges for this scientific disc[redacted]

A number of facts are causing this instability in my opinion! Some reiteration of historic developments and liabilities seems essential for a fair appreciation of the situation.
There are number of eras to consider if one wants to assess the actual situation of radioecology
The "fallout" era was the era of monitoring and of application of "radionuclides" for fundamental research and modelling.
The "Chernobyl" era was where the measurements and discussion about the doses to the general population and to located groups were at stake. The need was felt for environmental engineering and management and the economic and ecological implications there off. The conclusion could also be drawn that the need exists on the long term for "integrated (holistic) assessments" of a strong interdisciplinary character, taking into account the obviousness of "mixed pollution situations" and the manifold of environmental and economic factors! The opportunity to further assessment of similar situations presented itself as well as the additional testing of environmental assessment methodologies.
Simultaneously almost, radioecology was confronted with "acute" problems in arctic areas!
A regained interest also for "effects on biota" is to be noticed with a specific endeavour to adapt appropriate regulations consequent to changes of the paradigm that "when Man is protected, the environment is protected"! This apparently does not hold for all environmental and human conditions!

A number of choices could then be made for the safeguarding of the radioecological knowledge acquired in the last decades!
It could be by carrying on with straightforward radioecology, very much focusing on "nuclear-related matters", limiting itself to application of acquired knowledge in its own field. Effects on biota, "arctic" and similar problems, radioecology for dose assessment, they all represent a selection of these issues. A strong effort could also be made to trying to close the gap between radioecology on the one hand and environmental dosimetry, dose assessment, risk assessment, environmental epidemiology, geosphere and waste handling on the other hand. One could question indeed how well these "supposed user disciplines" are aware of the assets of radioecology!?
However, this acquired radioecological knowledge is precious and certainly and undoubtedly interesting for other environmental scientific disciplines and methodologies. Therefore, an inclination towards closer interaction with other ecological sciences, involved in environmental assessments for other pollutants, could be envisaged. This should go hand in hand with an evaluation of assets of these other ecological sciences and approaches, setting up of "eco-equidosimetric methodologies" and comparison of environmental engineering and management practices at use in all these areas. Ultimately a search for new or little explored research areas, such as "Chemocapacity", and other could be carried out!

These choices will influence the future of the IUR. It may either choose to remaining a scientific society completely and only dependent on the fate of nuclear energy production, and of related environmental events. It may, however, also choose to endeavour to safeguard painstakingly acquired precious knowledge for the generations to come, by integrating and transferring this knowledge into the larger scope of conventional environmental research, with both parties

on the winning site. It would infer the strengthening of the publicity for the "state of the art" of radioecology and what it can signify for other scientific disciplines!

Cooperation IUR-IAEA

International coordination on the topic of environmental protection from radiation

IUR has taken initiatives for international co-ordination on the topic of protection of the environment from ionising radiation. On June 19 and 20 a coordination meeting was held with the participation of IAEA, EU research programme FASSET and EPIC, and IUR. This was followed by a broader meeting on the 28 of August, in Vienna between IUR, IAEA, and AMAP and representatives of national programmes. In the same week, an IAEA specialists meeting on this topic was held, with participation from several parties including IUR. IUR has agreed to take responsibility for establishing a web site that will provide an overview of ongoing activities in this field. The address is environment – IUR.

IUR Financial Accounts

OPERATING STATEMENT AS OF 31/12/99

ORDINARY	
Income	
Membership fees	8464.52
Interest	868.97
Transactions amendments	314.82
Third party support	14402.52
NRPA doses to biota	1000.00
Total income	**25050.83**
Expense	
General Assembly	-1757.39
President	-4789.20
Vice-Presidents	-3084.34
Treasurer	-655.27
Web site	-857.86
Board of Council / Others	-118.59
Newsletters	-5594.04
Support for FSU participation in DGXII activities	-1437.70
Bank costs & interests	-749.87
Exchange difference	-1618.94
Total expense	**-20663.20**
DEFICIT ORDINARY	***-4387.63***
SPECIFIC ACTIVITIES	
Contract DGXII	
Income (for 1998 activity)	55330.05
Expense (for 1999 activity)	-63778.90
Deficit	***-8448.85***
AMAP activities 1999	
Income	43034.32
Expense	0.00
Surplus	**43034.32**
SURPLUS SPECIFIC ACTIVITIES	***34585.47***
NET SURPLUS	***38973.10***

BALANCE SHEET AS OF 31/12/99

ASSETS

Income to receive from 1999 DGXII activity	29229.00
Cash bank	60792.07
TOTAL ASSETS	***90021.07***

DEBTS & ACCRUALS

Outstanding payments to be made for 1999 activity to Suppliers in 2000	16248.45
Total Debts	**16248.45**

Accruals

Income carry over – for doses to biota studies	9467.25
Total accruals	**9467.25**

TOTAL LIABILITIES	***25715.70***

NET	***64305.37***

EQUITY

Fund Balance

Beginning balance Prior Year (1998)	-2619.00
Prior year adjustment (payments in 1999 for 1998 activity)	27951.27
1999 Result	**38973.10**

TOTAL EQUITY	**64305.37**

ANTICIPATED BUDGET 2000

Income	Euros	Euros	Item
Total fund balance	64305		
Third party income	2105		NRPA payment for newsletter 35
Interest	700		
ISTC payment	360		
Membership fees	10000		
Costs			
IUR management		6000	Newsletters
		2500	General Assembly
		2000	Bank Costs
		81	Web registration
		2000	ICSA accountants
IUR Board		4000	President
		2500	Vice Presidents
		1000	Secretary General
		1000	Treasurer
		500	Board Members
		1467	Board of Council meting Feb 2000
IUR Science		5000	Arctic/Antarctic task force
		1200	5th Int Conference Arctic
		2000	Doses to biota
		2500	Support for IUR members/Task forces
Totals	**77470**	**31248**	
Projected balance at end of 2000	**46222**		
Allocated expenditure for 2001 onwards			
Remaining "ring fenced" funds for Arctic/Antarctic		28234	
Remaining "ring fenced" funds for Doses to biota		6000	

FEES 2001

Membership grade	CIS, China Cuba, Colombia	Central Europe	Other countries			
	$	$	EURO	$	BEF	£
Student	7	10	20	21	800	13
Regular	14	20	50	53	2000	32
Senior	21	30	70	74	2800	45
Fellow	21	30	70	74	2800	45
Emeritus	7	10	20	21	800	13
Honorary	0	0	0	0	0	0
Supporting	>140	>200	>400	>420	>16000	>260

New members

From May 2000, the Executive Committee has accepted 20 new members to IUR:

Ronny Blust	Belgium
Karine Beaugelin-Seiller	France
Jean-Christophe Gariel	France
Ouafae El Ganaoui	France
Nadia Pérot	France
Philippe Calmon	France
Pascal Santucci	France
Christelle Adam	France
Catherine Rommens	France
Anton Bayer	Germany
Hiroshi Takeda	Japan
Shoichi Fuma	Japan
Carol Robinson	UK
Neil M.J.Crout	UK
Oksana Danilchenko	Ukraine
Alexander L. Pryshchepa	Ukraine
Alexander A. Orlov	Ukraine
Alexei B. Kalish	Ukraine
Sergey P. Irklienko	Ukraine

About our Senior Membership

The IUR Statutes foresee to grant some of their excelling Members with some demonstration of their outstanding performances to the benefit of radioecology and our union in particular. The former IUR Board already had granted this Senior Membership to Dr. **Martin Gerzabek**, from the Austrian Research Centre Seibersdorf, for his dedication to liaise between IUR and some other scientific societies like ESNA, the International Union of Soil Science and other organisations. This sort of liaising endeavours is the more meriting as it becoming increasingly the bedrock upon which the survival of radioecology is to be based.

By the former Board, also Dr. **Franca Carini** from the Istituto di Chimica Agraria ed Ambientale, Facoltà di Agraria, Piacenza, Italy was nominated for her work for radioecology and for the IUR. With perseverance and commitment, she has been working to assist the former Board in almost all of their endeavours where she spent many hours, not to say months next to her academic tasks to produce valuable syntheses and evaluations in order to satisfy the terms of the IUR's former contractual obligations. Franca Carini is still the dedicated liaison person between the IUR and the IAEA's BIOMASS Programme.

The latest person nominated for Senior Membership is dr. **Vasily Davydchuk**, Institute of Geography, National Academy of Sciences of Ukraine. His achievements in the field of radioecology as a geographer are remarkable and essential for the management of the Ukrainian territory, contaminated by the Chernobyl accident. His work represents also an opportunity for teaching and training purposes. The present IUR Board acknowledges through this nomination the big efforts he made to advance the structure and activities of the IUR in his country.

In Memoriam

Vsevolod Mavrikievich Klechkovsky (1900-1972)

Author: Rudolph Alexakhin.

November 28, 2000 is the centenary of the birth of Mavrikievich Klechkovsky (1900-1972), an outstanding scientist in the field of general and agricultural radioecology. His name, without doubt, ranks equal with the names of radioecologists such as R.S. Russell, L. Fredriksson, C.L. Comar, R.H. Wasserman and some others. It is a great pity that his name is not widely known to radioecologists in the West. In the USSR (Russia - CIS), his activity has become known only in the last 10-12 years, because he was engaged in classified works on radioecology at nuclear sites in the USSR.

From 1947 to1950, Vsevolod M. Klechkovsky carried out, in the USSR, the first experiments to study the uptake of technogenous radionuclides by farm crops and the effects of mixtures of radioactive substances on plants. From 1947, he was the head of the Biophysical Laboratory in the Timiryazev Agricultural Academy in Moscow, the first radioecological laboratory in the USSR. From 1958, V.M.Klechkovsky supervised scientific research in the South Urals in the area of the 1957 radiation accident at the Mayak nuclear plant, that resulted in the formation of the East-Urals radioactive trail. A radioecology research institution was established there and it is recognised as the *Alma Mater* of soviet radioecology. Between 1958 and 1972, guided by V.M.Klechkovsky, a comprehensive programme of radioecological studies was performed on the migration of radionuclides in different natural biogeocenoses - agrocenoses, forests, hydrobiocenoses. The effects of ionising radiation on natural ecosystems were assessed.

For the first time in the world, under the leadership of V.M.Klechkovsky, a wide range of countermeasures in agriculture were implemented to rehabilitate affected areas and normalise radiation effects. V.M.Klechkovsky was the founder of a soviet school of radioecology. V.M.Klechkovsky was an organiser and leader of many radioecological studies in the USSR. Russia (Obninsk) holds annual radioecological readings to Klechkovskys' memory. V.M.Klechkovsky was academician of VASHNIL, doctor of biological sciences, professor, State Prize winner (twice). Some of his works were translated into English (in particular his book "Modern Problems of Radiobiology. Vol.2. Radioecology. Moscow, 1971)".

In Memoriam

Nelli V. Viktorova
(1940-2000)

Author: Oleg Voitsekhovich

On August 8, 2000 after a painful disease, a nice person and cheerful woman, passed away, our friend and colleague Nelli Vasilievna Victorova. She was a brilliant scientist and an active member of the IUR playing her professional and public role quietly but efficiently.

She began her scientific research in the Institute of the Ukrainian Academy of Science in the middle of the 60s as a radiobiologist after having graduated at the Biological Faculty of the Kiev State University.

The scope of her interest was wide. She worked in basic radiobiology, studying the effect of cosmogenic irradiation on the organisms and on microbial aspects in radioecological research, studying morphological damages of irradiated plants, and radionuclides transfer from soil to plants.

In 1986, the Chernobyl accident opened a new page in her biography. From the first days after the accident, she has initiated the collection of plant leaves, damaged by radioactive aerosols. One of the first herbarium collections with leaf surfaces exposed to "hot particles" were prepared by herself and used as a plan-table for further autoradiography of these hot particles. At present it is a world known result and published manifold. She has worked a lot for the development and application of the autoradiography film methodology for use in radioecological monitoring.

She first worked as a team leader of the Chernobyl Department of SPA "Typhhon" in Kiev, studying different aspects of radioactive aerosol dispersion in the environment. Later she worked in the Ukrainian Hydrometeorological Institute, being responsible for physical and chemical aspects of radionuclides leaching from "hot particles" into soils and bottom sediments. Her attractive results on the "hot particles" disintegration study in the environment were an important contribution to the project ECP-3 and ECP-5 during 1991-1995 EC Chernobyl program.

Since 1998, she was involved in the INCO-Copernicus "PHYTOR" research project. Her study of radionuclide transfer from soils to willow plants in application of phytoremediation technology on the contaminated wetlands and Chernobyl flood plain have contributed greatly to the success of the project implementation. She was devoted and was always prepared to pass all her knowledge to the young people working with her.

Nelli was a good friend to many of us that worked closely with her and for those whom she had met only just once. She loved to talk, to discuss and to keep a warm atmosphere for the people who lived and worked around her. She had many friends in Ukraine, Russia, Belarus, UK, Germany, Belgium, Italy and in other countries. She liked friends and her home was open for everybody...

Nelli was a very humane and gentle person but with a strong character. She had known about her dreadful illness for long but always tried to keep it to herself, to keep on smiling and to carrying on with her work. She died from a malignant disease, but which unfortunately, we could not to save her from... !

Task Group on Environmental Protection

The work of the IUR Task Group on the environmental protection from radiation was presented at the IRPA conference in Hiroshima. The summary of the Topical Session on this issue is given below.

R.Alexakhin gave an overview of ICRP principles for radiation protection and addressed those relevant for environmental protection. The main focus of the session was however on the protection of the environment itself. All the presentations stressed that the current basis of the protection strategy is far from sufficient. The ICRP environmental statement which states that *if man is adequately protected then other living things are also likely to be sufficient protected* has been the basis of environmental protection. This statement is based on a belief, is not documented, and it may not always be true. There is therefore a need for a method of assessment of consequences for flora and fauna and a framework for protection. The International Union of Radioecology has for the last 3 years had a Working Group *on doses and effect in non-human systems*. The work of IUR has benefited greatly by the system proposed by R. Pentreath. The IUR working group has worked further on the outline how to deliver such a system for the protection of the environment from radiation and a framework to make it work. P. Strand, General Secretary of IUR and R. Pentreath presented this system and framework.

At the present time effects of radiation on flora and fauna, have been summarised in many reviews (e.g UNSCEAR 1996. However one of the main conclusions to emerge from the IUR Work Group was that a more coherent approach was required with respect to the assessment of doses to biota and the protection of the environment from ionising radiation. Information has not been structured in a suitable way to conduct an Environmental Impact Assessment and it is not easy to use it to assess environmental impacts. A system and framework is required.

The system and framework which was outlined takes into consideration the fact that that the behaviour of radioactive matter in an environment represent a very complex system with many species and ecological parameters and an enormous variability.

It was therefore stressed that to develop a coherent and logical environmental impact assessment methodology for ionising radiation, a framework, within which generic organism and reference models can be applied and results analysed, is essential

The framework and system presented included

- the need for a new unit
- reference dosimetric models
- reference environmental geometries
- reference faunal and flora types of organisms
- broad biological endpoints for radioactive effects
- standard methods for calculating exposure and
- basic principles for estimating the consequences for population and ecosystems

As a result of this work, it was emphasised that it should be possible to define the appropriate level in the biological hierarchy (over the range from cell to ecosystem) at which protective action should be directed.

The choice of reference organisms could ideally be based, amongst others, on criteria such as (a) organisms which, by virtue of environmental transfer and concentration factors, have the greatest potential for exposure, radioecological sensitivity b) organisms which have a high radiosensitivity (c) organisms which are important to the healthy functioning of the ecosystem. The final choice will probably depend upon more single criteria.

The reference exposure pathways and the reference model to describe it should be based on the acquisition and synthesis of information concerning the characteristics of selected ecosystems, particularly those that could be expected to influence the behavior of radionuclides and their uptake by the biological components. The available information and knowledge of the environmental behavior of radio nuclides in the chosen ecosystems, combined with modeling studies, should make it possible to develop simple reference models for the simulation of radionuclide migration and uptake to the whole organism (and organs if applicable) for reference species living in representative terrestrial and aquatic ecosystems.

It was stressed by several of the speakers that there is a need to develop dosimetric units for flora and fauna. Current knowledge only including absorbed dose expressed in Gray however there is a need to incorporate the idea of relative biological effectiveness (RBE) for different types of radiation, species and end-points and to develop the concept of equivalent dose for flora and fauna.

For effects there is especially a need for quantifying the dose effect relationships for specified endpoints for the flora and fauna. It is proposed to focus on mortality, reproduction, and cytogenetic effects, but also behavioural and immunological effects may be addressed. The chosen end-point would influence the development of the dosimetric models.

The effect of acute irradiation on a single simple, closed, self-maintaining ecosystem was examined by M. Doi. The data obtained allowed the development of a computer model, and also to demonstrate that a non-lethal; response in one component species could trigger a lethal response in another. This demonstrated the need for a holistic approach for the environmental protection.

The future need for work in this topic was clearly recognized through the presentations in this session. The International Union of Radioecology has an ongoing working group on this issue. This is dealing with terminology, identification of knowledge gaps, criteria, developing the system and framework, and address the need for international consensus. The IUR has provided one report on the issue to the European Commission EC *Doses and effect in non-human systems* this year and will in the beginning of next year have a new report on the topic.

The International Atomic Energy Agency has provided a discussion report on *Protection of the environment from the effect of ionizing radiation*, and is planning further work. The need for international cooperation in this issue

was stressed, but also the need for research for the development of the system and framework. In that sense it was positive that the EC had addressed this issue in the Fifth Framework with support for the two research project FASSET and EPIC.

ICRP informed during the IRPA conference that also they would look into the issue of protecting the environment and establish a task force during this year.

IUR has taken initiatives for international co-ordination on the topic of protection of the environment from ionising radiation. On June 19 and 20 a coordination meeting was held with the participation of IAEA, EU research programme FASSET and EPIC, and IUR. This was followed by a broader meeting on the 28 of August, in Vienna between IUR, IAEA, and AMAP and representatives of national programmes. In the same week, a specialists meeting on this topic was held, with participation from several parties including IUR. IUR has agreed to take responsibility for establishing a web site that will provide an overview of ongoing activities in this field. The address is environment – IUR.

The report from the IUR representative at the specialist meeting is given on this side.

Summary from the Working Group Sessions at the IAEA Meeting, Vienna, 29th August – 1st September 2000-09-06

The following provides a summary given by Justin Brown of the key points relating to the Working Group sessions organised during the Meeting.

1.Ethical dimensions and principles

Panel members : Mary Clark (Leader), Alex Zapantis, Bliss Tracy, Deborah Oughton.

The basis for establishing criteria – the goal should be to establish a transparent, consistent basis for the purpose of evaluating the consequences of any proposed action.

When applicable criteria should be consistent with and complementary to (i) the approach used in other systems for the protection of the environment (and for the protection of man) and (ii) sustainable development.

In establishing criteria there are several issues for consideration

(i) whether to include background
(ii) whether there is need for a biological monitoring programme as part of a system and if so, whether criteria need to be related directly to the outputs of that programme.
(iii) whether effects are measureable/detectable/to what extent adverse
(iv) whether there is need for criteria to be readily measurable and directly related to impacts
(v) the variability and distribution between human and environmental interests.

The objective should be to minimise unnecessary impacts on the environment. This includes maintaining biodiversity and sustaining ecosystem function. However, given the lack of knowledge with respect to how an ecosystem functions (there are complex reactions within it) this may need to be accomplished by protecting populations within it. In terms of what is directly affected by ionising radiation, the focus should be one of protecting biota.

Additional considerations for a framework include :

(i) concept of risk for application to an environmental assessment
(ii) radiation sensitivity
(iii) ecological significance
(iv) site-specific needs

"harm" can be defined as "change inconsistent with what we are trying to protect".

While recognising that there may be a need to accept a broad definition for "harm" (within the framework for international laws), the definition should include the following quantitative considerations :

(i) changes in the environment
(ii) biodiversity
(iii) spatial and temporal effects

The quantitative considerations should inform the qualitative ones such as social, cultural and legal aspects. With respect to the protection of the environment from ionising radiation, the term environment, defined in the framework of international law, includes man, biota, abiota, physical surroundings and their interactions.

Ethical principles/dimensions

Since we have limited knowledge of effects on the system and since the environment is fragile and capable of being damaged we need to protect the environment for a number of ethical view-points/reasons including the intrinsic worth, public interests and future generations. It is important to have "stakeholder" involvement and to recognise potential conflicts with the system for the protection of man.

2. Endpoint specification

Panel members : Carl-Magnus Larsson (Leader), Patsy Thompson, Tom Hinton, Carmel Mothersill.

This working group covered a number of themes :

(i) Target organisational level (what do we want to protect)
(ii) Endpoints – mechanistic, deterministic, stochastic and *concentration/doses* endpoints were considered in the context of specific requirements
(iii) The usefulness of critical or reference organisms and the consideration of organsè biota è ecosystems
(iv) Future priorities

Managerial principles were not covered in the discussions.

What are we trying to protect?

Theoretically :

It is generally recognised that populations are to be protected. Exceptions to this include endangered species, and cases such as endocrine disruption where there is clearly harm but no observable change in the

population. The appearance of tumours etc., although not evident in population changes is cause for environmental concern.

Practically :

There is a requirement to link exposure with potential effects/harm. The vast majority of effects data relates to individuals, cellular and sub-cellular effects. There are few data that link doses to effects at the population or community level.

Ethical dimension :

There is a clear lack of knowledge. With respect to sustainable development there is a need to avoid environmental deterioration so that future industrial practices are possible. Environmental protection should aim to prevent releases of radioactive and hazardous substances to the greatest extent possible. The conclusion is that trying to define at what level of biological organisation we want to protect is not really an issue.

Critical reference ; organs/organisms/ecosystems

Critical organisms can be considered to be those most at risk from a contamination event.
Reference organisms can be considered those organisms that are representative of an ecosystem

Considerations required when defining a critical species include : Radionuclides; distibution of radionuclides; sensitivity (some ecosystems were considered to be more sensitive than others including Arctic, extreme, stressed and old ecosystems; the sensitivity of organs within the organism and stage of life are also important in defining sensitivity), dose-rate, life span and time-frame.

The question of what is critical from a societal perspective was not considered.

Generally important	**What should IAEA do ?**
Co-operation	Be a focal point for information exchange and coordination
System is required but parallel systems should be avoided	Be a focal point for information exchange and coordination
Research - dose/effect/response - internal radionuclide deposition - appropriate RBEs - ecological significance of genetic change - mixed contaminants	Collect data on endpoints and their sources
Priority to develop a Safety Guide	Do it !

Priorities

Several priorities were identified :

3. Quantities, Units and Compliance

Panel : Per Strand (Leader), Dennis Woodhead, Steve Domotor, Rodolfo Avila

The first question to be addressed was whether absorbed dose/dose-rate is relevant for assessing dose effects in biota. In the first instance the use of absorbed dose provides a basis for all radiobiological data. In the future we will be required to identify effects in biota that may be significant at the dose rates of interest. It was a group view that this was a useful tool and should not be abandoned.

The question of whether a generic or reference organism approach was applicable in any new system. Such an approach appears to be useful when applied at a specific level in an assessment. At the initial level we might apply a screening model where conservative assumptions are made, e.g. high CFs and K_ds, organism is infinitely large for internal dose calculation and infinitely small for external dose calculation. At the next level of assessment (if required) a reference organism approach would begin to introduce realism. Target organisms would be selected based on radioecological sensitivity, radiosensitivity and ecological sensitivity. Tissue and organ data need to be compiled with possible emphasis on collation of reproductive organs data. Stable element data are also relevant. A more detailed assessment would require a full site-specific analysis including the application of realistic dosimetric models and the use of site-specific CFs, K_ds etc.

Most of the models currently applied are equilibrium models, which may not always be applicable. It may be suitable to compare the equilibrium models with dynamic models that take account of lag, biological half-lives etc. The presence of long-lived organisms necessitates the careful choice of dose assessment models.

It appears that screening and reference models are complimentary and should be developed in parallel.

The question of RBE was considered. There was an agreement that transparency was required in revisiting

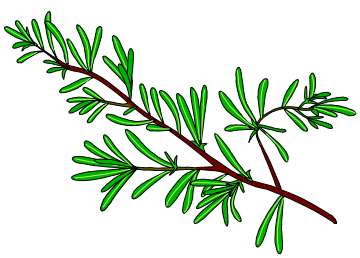
old data. It would be useful if all data were reported in the units of absorbed dose rate but that low and high LET radiations should be reported separately. Quantity equivalent doses (e.g. Sv) should not be employed at present although it is recognised that one can observe different equivalent doses for the same absorbed dose. In the future it is possible that some form of radiation-weighted absorbed dose will be required. This would be made up of the components of the low LET radiation and the high LET radiation weighted accordingly. The weighting factors employed would relate to the RBE of selected endpoints and would be connected to the question of what we are trying to protect. A Canadian team have agreed to analyse the available data and to suggest weighting factors for relevant end-points.

The relevance of the environmental transfer models used in the assessment of human exposure to a system for assessing environmental impact was considered. These current models appeared to be useful but had certain limitations. They were suitable for application to environments inhabited by man. However these models are specific to the human food-chain whereas in the protection of the environment we may be more concerned with the environment that is not accessible to man. Air tranport pathways may require consideration, e.g. transport to high alpine areas etc.

It was agreed that protection of biota should be considered in terms of dose received and should be radionulcide - end-point specific. Limiting dose rates can be interpreted in terms of radionuclide concentrations in relevant media (soil, water, air etc.). Concentrations and contamination densities relate to environmental quality standards and thereby cover a wider scope than an assessment relating solely to flora and fauna. However, the terminology connected to "primary standards" appears to be purely a question of semantics. The US DoE screens in terms of concentrations but doses are equally applicable. It was suggested that standards could be set in the form of an uncertainty distribution that would take account of uncertainties in (i) transport models, (ii) dosimtery models, (iii) dose-response relationships. This may allow the probability (or risk?) of harm to be assessed. Spatially variable contamination could be considered in this type of uncertainty analysis. As a starting point one would need to define a population. In addition the effect of time-averaging should be explored. The life span of an organism, of course, is important in the assessment.

Finally the question of whether our present methodologies of risk analysis etc. are unnecessarily complicated. It was concluded that they probably were if one considers the lack of data and presents a powerful argument in favour of adopting a screening type approach.

In terms of future approaches, it was suggested that the EC projects FASSET and EPIC, the IUR Task Groups and the IAEA should cooperate closely on the development of a new environmental protection system.



Soil-to-Plant Working Group

XXXth annual meeting of ESNA (European Society for New Methods in Agricultural Research) and of the working group soil-to-plant transfer of UIR in Keszthely/Hungary, 26-30 August 2000

Report of the Chairman of working group 3 (soil-plant relationships)

The annual meeting of working group 3 dealt with 24 contributions, 14 were presented orally and 10 as posters by scientists from 11 countries.

The first paper by Matin/IAEA introduced the IAEA co-ordinated research programme "The classification of soil systems on the basis of transfer factors of radionuclides from soil to reference plants" and the principle concepts behind this approach. A couple of talks addressed the time dependent radionuclide transfer into plants and translocation within plants following soil and/or foliar contaminations. Brambilla/Italy presented a detailed model study on translocation of Cs, Sr and Zn from green plants into tomato fruits. Oncsik/Hungary demonstrated the seasonality effect with respect to Cs-transfer into rice grain following contamination of rice plants at different growth stages. In a related poster, Haak/Sweden described the reduction half-times of Cs and Sr in grass and cereals during the first weeks after an artificial contamination. The data of both contributions are useful for radiological assessment models, especially concerning the first year after a fallout. Effects of soil characteristics and yearly variations on Cs.-transfer into soybean and sunflower applying the fluxes concept were reported by Skarlou/Greece. Goncharowa/Byelorussia presented a plant physiological study on the impact of macronutrient cations on the Cs and Sr influx into roots of cereals. Zibold/Germany presented a well-calibrated model of Cs-fluxes in forest ecosystems based on a forest site near Lake Constance. After correction with different parameters, it could be concluded that the decrease of the ^{137}Cs-contamination levels of mushrooms at present follows its physical decay.

Soil management and questions of plant nutrition were addressed in several presentations. Gerzabek/Austria reported on sensitive organic carbon pools in soil that react more rapidly to management changes and are related to soil microbial activity. Hegedüs/Hungary compared two long-term field experiments in Europe with respect to soil organic matter and biological properties.
Use of mineral fertilisers was discussed in several papers. Budoi/Romania presented mathematical solutions to the problem to derive optimum complex fertilisers from fertilisers containing more than one macronutrient. The optimum use of phosphorus and complex fertilisers was elaborated in a couple of papers elucidation Turkish conditions (Brohi/Turkey), orchards (Stanica/Bulgaria) and extremely sandy soils (Gavriluta/Romania). In the latter mentioned poster, it could be shown that fertilisers in tablet form may decrease nitrogen losses in sandy soils considerably. Budoi/Romania especially reported on the optimum pH and base saturation conditions to optimise plant growth. The respective recommendations for more than 500 plants will appear in the proceedings. The application of foliar fertilisers was ad-

dressed by Özcan/Turkey, Brohi/Turkey, Soare/Romania and Dana/Romania. The latter paper related the micronutrient content of hybrid maize seeds obtained by foliar fertiliser application to the seed quality. Two presentations focussed on grapevine nutrition. A detailed study on the optimum potassium fertilisation level taking into account cation ratios in soil and plants and grape juice quality parameters was presented by Licina/Yugoslavia. The plant physiological aspects of lime-induced chlorosis was explained by Serdinescu/Romania. It could be concluded – as already shown in literature – that not the low Fe-content of grapevine leaves are the reason for chlorosis, but the inactivation of Fe. Differences between sensitive and tolerant varieties could be shown by quite simple cation ratios, which might be useful for selection purposes.

Additional posters presented data on e.g. heavy metal adsorption in soil (Madjar/Romania) and micronutrient and heavy metal distribution in soils of Vojvodina (Sekulic/Yugoslavia).

The proceedings of the meeting will be published later this year.

The participants of the working group sessions thank the local organisers Prof.Szabo and Dr.Karpati for their efforts and the warm welcome.

The XXXIth annual meeting of ESNA will be held in Chania/Greece during the second week of September 2001.

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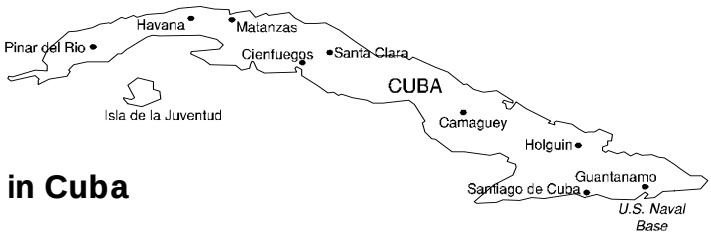
Chairman working group 3
Soil-plant relationships
Liaison officer of IUSS to UIR

Keszthely, 29.08.2000



Radioecology in Cuba

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Introduction

Cuba is a long and narrow island that is located in the Caribbean Sea, at the entrance of the Gulf of Mexico, between the latitudes 19º-24ºN and the longitudes 72-88W. It possesses a tropical climate of savanna, with defined periods of rain and dry. The national territory is practically flat in all its extension with three mountainous groups of relative importance. The maximum altitude at Pico Turquino is in the East of the country.

The country doesn't have facilities that potentially could liberate significant quantities of radioactive material to the atmosphere and at the moment construction of the Nuclear Power Plant at Juraguá is stopped. During these years only the global radioactive fallout has affected the environment. At the regional scale Cuba is could potentially be affected, in the event of serious accident, the nuclear power stations of United States of America and the nuclear power plant of "Laguna Verde", Mexico.

In this report the main radioecological studies carried out in the country are shown. In Cuba, the Center for Radiation Protection and Hygiene (CPHR) of the Agency of Nuclear Energy (Ministry of Science, Technology and Environment), has developed these studies, supported in the Environmental Radiological Surveillance Laboratories of Cienfuegos, Camagüey and Holguín.

Main studies developed.

Radiological study of areas of possible location of nuclear facilities.
The radioecological studies in Cuba commenced in the eighties, at a time in which possible locations for nuclear facilities were being investigated. The following examples can be mentioned:

- Environmental radiological monitoring (preoperational program) of the nuclear power plant of Juraguá (in construction) and preliminary characterization of the background environmental radioactivity in the area of the possible location of the nuclear power plant "Norte de Oriente". Characterization of the terrestrial and marine ecosystems were carried out and radionuclide transfer in the environment was determined to predict the pathways of transfer of radioactive material and to estimate the possible doses to the population. In this period the codes " DIFU " and " MARCEN " were developed to carry out the evaluation of the radiological impact due to routine releases of gas and liquid (respectively).
- Radiological characterization of the background environmental radioactivity of the Nuclear Investigations Center "La Quebrada". In the frame of this work the first results were obtained for the Sr90 transfer coefficients from soil to grass and grass to milk in the area in which the fundamental economic activity is dairy production.

Environmental Radiation Monitoring Network.

The accident at the nuclear power plant at Chernobyl on April stimulated the development of warning systems for nuclear accidents all over the world. In Cuba this resulted in a network for the surveillance of outdoor radiation levels, the National Environmental Radiation Monitoring Network (RNVRA). The RNVRA start to work in 1987, becoming the basic instrument of the National Environmental Radiation Monitoring System. The RNVRA consists of 18 measuring stations, all of which control the integrated gamma dose with thermoluminiscent dosimeters. At four so-called "regional stations", the control of the radioactive concentration in aerosols, fallout and milk and the gamma dose rate are carryied out. Recently the radiological control of the marine ecosystem was incorporated into the permanent monitoring programme of the national network.

The main objectives of the network are:

1. To detect possible alterations of the background environmental radioactivity as a consequence of a contamination at a regional or global scale.
2. In the event of an alteration of the background environmental radioactivity, to give the necessary information to evaluate the risks to the population and the environment and to help on the intervention.
3. To maintain the radiological control of the environmental objects subject to regulations, for example foods and bottled waters, etc.

Radiological characterization of interesting areas**.**
The radiological characterization of areas of interest has been other of the important works carried out:

- The radiological characterization of the north coast of the Ciego de Avila, Camagüey and Las Tunas Provinces which are regions of great tourist interest.
- The radiological characterization of the gold mine "Cobre-Mantua", located in an area with high levels of natural radiation.

Other important studies.

During these years other projects relating to environmental activity have been developed:

- Estimation of the radiological impact of the use of phosphate fertilizers in citrus cultivation. In this work punctual values were determined for the Ra226 transfer coefficients for the ground to stem, leaves, shell and juice of the fruit; a smaller transfer to the juice than to the rest of the parts was proven.
- Safety analysis of the Cuban radioactive waste evacuation system. In this work an analysis of the radiological impact of the proposed evacuation system was made and to identify the sensitive elements to the long-term safety. Analysis of two migration models' sensibility and the radionuclides transport in the geosphere were made. These works are carried out in co-operation with the IAEA.
- Study of the doses received due to the consumption of Ra226 contained in drinking water.
- Determination of the doses received by the consumption of foods.
- Determination of the doses received by the exposure to the cosmic radiation.

Conclusions.

During recent on a small scale studies have been developed involving radioecological characterization of tropical environments.

On Radiecological Studies in Armenia

Authors:

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Emma A. Saghatelyan -Doctor of Geological and Mineralogical Science, Professor - State Engineering University of RA (SEUA).

Artavazd A. Petrosyan - Candidate of medical sciences - Nuclear Power Station of RA.

I. Introduction.
Republic of Armenia occupies the NE part of Armenian highland and central part of Lesser Caucasus between 38 and 42 N^0. The country's surface features a combination of mountain ridges, volcanic cones, highland plateaus, alluvial plains and narrow riversides. The characteristics of Armenian territory are: strong vertical belts ranging from 800 to 4092 m; high seismicity; presence of a nuclear station.

II. Brief history.
The state control of ionizing radiation in Republic of Armenia has been performed by the authorized governmental body, the State Hygienic Control and State Atomic Control. Control for concentrations of radionuclides in environmental objects (potable water, water from open water bodies, soil, vegetation, vegetables, etc.) has been performed by planned regular radiological studies. From the territory adjacent to the nuclear station, samples of potable water, water from open reservoirs**,** vegetation, vegetables, fruits and others are taken monthly.
In the last years special scientific works were performed by different groups [1-17].

III. International collaboration.
Anna G. Nalbandyan participated in and is certificated from the Regional Basic Training Course on Radiation Protection organized by IAEA.

IV. Main results and current research.
CENS NAS RA - Radiological studies in Armenia by were started by us in 1958 and continue hitherto. This activity is mainly monitoring and in additions some aspects clarifying distribution and migration of global radionuclides in system precipitation-soil-vegetation are studied.

As in other mountain regions, in Armenia the altitudinal zonality is very clear. Distribution patterns in precipitation, its chemical composition and radioactivity, natural soil and climatic conditions, and man-made pollution of atmosphere depending on elevations are investigated in detail.

Soil concentrations of ^{90}Sr and ^{137}Cs follow the following descending sequence: mountain meadow>forest-black earth>chestnut-brown. However, zonality in the distribution of radionuclides is often disturbed due to redistribution in certain landscapes. In soils, ^{90}Sr occurs mainly in movable easily plant available forms. ^{137}Cs is usually bound by soil particles as non-exchangeable forms. A map of the distribution of ^{90}Sr and ^{137}Cs in soils as recorded in 1984 had been compiled (scale 1: 1000000). Accumulation of radionuclides in meadow plants and agricultural crops had been studied. An increased concentration of radionuclides in hay of mountain meadow and forage vegetation had been found. The coefficient of accumulation of ^{137}Cs by plants is considerably lower than of ^{90}Sr. Field experiments show that the use of fertilizers contributes to a decline in radionuclide concentrations in vegetation.

A criterion of relative purity is the natural background value of radioactivity which is determined by presence in different soils of thorium, uranium, radium, products of their split, potassium, rubidium. Their total activity concentration is 522.7 Bq/kg, of which 68% are made by K. We accept the natural level of b-activity in soil (background) as 500-600 Bq/kg. Cumulative b-activity provides a qualitative characteristic of radioactivity level and can serve as indicator of environmental pollution.

Surveys of the region close to the Armenian Nuclear Station (ANS) are carried out [6]. Based on cumulative b-activity, concentrations of ^{90}Sr, ^{137}Cs in soils, agricultural crops, water and precipitation, it can be seen that environmental pollution by artificial radionuclides happened in previous years due to the nuclear weapon tests, i.e. had a global pattern. Additional radioactive pollution for the whole period of operation of ANS is not found. Since 1958 a large number of measurements of b-activity in different types of soils have been performed in Armenia.

The data are summarized and presented in histograms. In samples dated 1951-1954 b-activity fluctuated by 70% within 500-550 Bq/kg what is a natural level. In 1959, b-activity began to rise. In 1997-1998, an increase in b-activity is also observed: 40% of samples have activity 650-750 Bq/kg and 11% - 750-800 Bq/kg.

After the catastrophe at the Chernobyl Nuclear Station, we performed additional soil and plant sampling and analysis. The presence of ^{137}Cs in soils indicated that emissions had reached Armenia. Precipitation contained mainly short-living isotopes. Concentrations of ^{90}Sr and ^{137}Cs in soils were comparable with the level of global pollution in 1980-1984 [7].

The mapping of soils in Yerevan city continues [8, 9]. Cumulative b-activity is very patchy and about 3% of samples have shown radioactivity close to background values. Most samples had increased b-activity - 650-750 Bq/kg, and 20% of them had 750-800 Bq/kg. Along with increases in b-activity, concentrations of ^{137}Cs, ^{232}Th, ^{40}K are also rising.

ACTUAL PROJECT: Studies on migration of natural and artificial radionuclides in natural environment taking into account the man-made impact. The project head Dr. V.L. Ananyan. Contact information: 375025 Yerevan, Abovian Str. 68. Tel. (3742) 560357, fax (3742) 580254, E-mail: ecocentr@pnas.sci.am

SEUA - Studies of radon commenced in 1986. The complex interpretation of data derived from a long-term monitoring of radon in different geological environments and seismicity of territories is performed and research on radiometric parameters of ground and building materials is carried out. The Spitak earthquake experience of December 7, 1988, showed for the first time that earthquakes cause intensive and prolonged radon splashes which, while rapidly dispersing in the open space of close-to-earth atmosphere, are evident in covered premises (dwelling houses, schools, kindergartens) even if they are at considerable distance from the epicentre of the earthquake. This effect multiplies the radiation influence of the population. The interval of splashes includes the period starting from the first-shock and ending with the last after-shock.

The radiation intensity and duration of the influence are directly correlated with the force of earthquake and radon emanation field and distance from earthquake epicentre. The results of indoor radon monitoring (1987-1993) carried out in Yerevan city located 120 km far from the earthquake epicentre served as ground for such a conclusion. Calculations of equivalent radon radiation dose show that compared with 1987, 1991 is characterized by lower radiation doses of 0.183-0.445 mSv. In January 1989 the effective equivalent radiation dose due to radon and its radionuclides made up about 16 mSv, i.e. 50 times more than the mean equivalent radiation dose due to radon of the above-mentioned years. In the epicentral part of the earthquake heart the level of background radiation in dwelling houses, as well as the effective radiation dose due to radon, was many times higher.

Consequences of radiation influence on the population of the territory of Armenia are malignant cancer forms in disasters zones, prevalence of lung cancer, depression, etc (statistical date) [10-17].

ACTUAL PROJECT: Radioecological studies on behaviour of radon in different geological environments under stable and extreme (earthquakes) conditions of Earth crust. Studies on causes of accumulation of radon in urban and rural settlement areas in Armenia. The project is important for all seismic areas. The project head Dr. Prof. E.A. Sagatelyan. Contact information: Armenia 375009, Terian Str. 105. State Engineering University of the Republic of Armenia. Tel. (3742) 581114, fax (3742) 151068, E-mail: srd@seua.am

V. Difficulties and desiderata

Radioecological group needs a modern laboratory measuring equipment and experiences lack of financial support for experimental and monitoring studies.

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SETAC

SOCIETY OF ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY

the leading international interdisciplinary, scientific society for biologists, environmental chemists and ecotoxicologists in universities, government or industry.

About SETAC-Europe

The Society of Environmental Toxicology and Chemistry Europe (SETAC-Europe) is a professional society established to promote the use of a multi -disciplinary approach to solving problems of the impact of chemicals and technology on the environment. SETAC-Europe is an international organisation that provides a vehicle for scientists to exchange information and share opinions across borders and across disciplines. It does so by organising international and national meetings, workshops and symposia, by publishing a monthly scientific journal, a regular newsletter and books. It has established a Young Scientist Award to recognise outstanding work presented at its annual meeting. It also recognises outstanding educational achievements through its annual Environment Education Award.

SETAC-Europe was founded in 1989 and already has over 850 members from 30 countries.

Benefits

Members:

- Receive Environmental Toxicology and Chemistry, a peer-reviewed journal with over 2.000 pages annually (student- members may take an optional subscription).
- Receive SETAC-Europe News, a bimonthly newsletter with news about local, regional and international meetings, job advertisements and general environmental topics;
- Pay a reduced fee for participation at SETAC meetings, worldwide;
- Are entitled to a discount for SETAC books and reports;
- Are joined to a network of 4000 members worldwide through the membership directory.

Our Society Objectives

Science: To bring together expertise in academia, industry and government to promote good science in the evaluation of relevant environmental issues.

Education: To support and promote the development of environmental toxicology and chemistry through environmental education and training and to encourage the participation of young scientists.

Technology: To provide a forum for the exchange of ideas and approaches to new techniques and technologies in a wide variety of disciplines including Life Cycle Analysis (LCA).

Awards: To recognise outstanding scientific contributions in environmental education and the work of young scientists through specific awards supported through both the SETAC Foundation and industry contributions.

Communication: To foster the widest debate on environmental issues through a monthly international journal, annual meetings and focussed workshops and to encourage the development of SETAC worldwide.

Council

SETAC-Europe affairs are managed by a Council elected by the voting members. The Council is composed of members of government, business and academia, as equally as possible. Each year, one third of the Council members is replaced with new members, elected from and by all voting members.

International Activity

The North-American sister organisation SETAC was established in 1979 and has over 3.000 members. The two organisations cooperate closely in order to serve the interests of environmental scientists worldwide.

Membership

The classes of SETAC membership are: Member, Associate Member, Student Member, and Sustaining Member (organisations). Applicants for membership must share the stated purpose of the Society.

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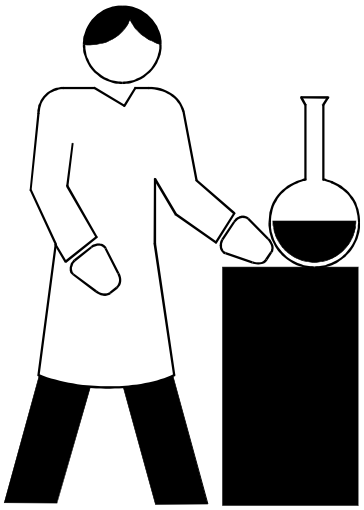

Long-Term Environmental Behaviour of Radionuclides Recent Advances in Europe

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ABSTRACT
This document provides an overview on the recent advances in Europe concerning the long-term environmental behaviour of radionuclides. It describes and illustrates the most significant scientific achievements gathered through three European projects, PEACE, LANDSCAPE and EPORA, which have been co-funded by the European Commission (DGXII) under the Nuclear Fission Safety Programme.

The improvement of radiation protection issues requires an accurate understanding of the behaviour within ecosystems of the radionuclide contaminants. The three projects have therefore been focused on the soil-plant system of agricultural lands and semi-natural forest ecosystems based on both, experimental approaches in controlled conditions and in the field. A particular emphasis is devoted to unravelling intra-compartments loads and inter-compartments movements of ^{137}Cs, ^{90}Sr and $^{239+240}Pu$, addressing also, for the first time, the potential influence of non-radioactive additional pollutants (heavy metals). The variety of conditions encountered in Europe is encompassed through a wide selection of experimental sites ranging from Mediterranean up to Boreal ecosystems. Experimental data acquisition and mechanistic modelling are synergistically developed in order to promote access to improved assessment predictions in an accidental situation.

The knowledge generated first includes the redistribution of radionuclides in the soil-plant system with emphasis on vertical migration in soils and root uptake by plants. Next it provides recent advances into the mechanistic modelling of these features. From the new data gathered through three years of investigations, essential conclusions on contamination discharge via run-off water are drawn, and insights discussed with respect to counter-measure, and spatial variations. Preliminary conclusions are finally derived in the perspective of dose assessment, and areas deserving further research identified.

What have we learnt?

- It is of paramount importance to know the soil solution composition in order to understand radionuclide transfer to plants.
- On untilled mineral agricultural soils, the migration of ^{137}Cs and of ^{90}Sr remain similar, and the depth profiles are established early on, with very slow further evolution.
- On the forest podzolic soils studied, migration of ^{137}Cs is pronounced, with increased amounts in the mineral layer ten years after an aerial deposition.
- The classically used K_D, as determined in vitro, does not allow an acceptable prediction of migration. The initial soil structure and hydric conditions upon contamination are important.
- During the past decade, there is a general decrease of 60-80 % in ^{137}Cs concentrations in ground vegetation, fungi, mosses and lichens at both temperate and boreal forest sites studied.
- More than a decade after Chernobyl, the total inventory of ^{137}Cs is still rising in pine trees of boreal forests.
- The forest models currently developed yield agreeing estimates of the ^{137}Cs concentrations in the different compartments of the ecosystem, taking natural variability into account.
- An increasing load of heavy-metal pollution in boreal forests modifies the radionuclide status in podzolic soils and its subsequent transfer to plants.
- Fertilisation can be a beneficial tool for restoring contaminated forests, as well as for the remediation of the state of agricultural lands in severe fallout situations.
- There is almost no ^{137}Cs loss via runoff water from boreal forest ecosystems except from the wetter portions of bogs.
- Spatial variations in radionuclide deposition are dominant and largely cancel out evolution over time and the influence of climatic intermittence.
- Variability of ^{137}Cs uptake by moose is caused more by spatial variation in deposition and the normal movements of the animal than by variations in diet selection or intake.
- The ^{90}Sr contamination of plant food products is important for internal dose assessment and may be affected by additional non-radioactive pollution.

What is still needed?

- Reaching a better understanding of the concept of “bioavailability” and its applicability in different ecosystems.
- Clarifying the importance of climatic conditions immediately after radioactive deposition.
- Identifying what is needed for the assessment of radiation doses and where basic research can afford support.
- Investigating the scientific pertinence of dose to ecosystems.
- Distinguishing dose distribution over time from different ecosystems.
- Unravelling the influence of chemical industrial pollutants on the behaviour of radionuclides in the environment.
- Further model development and testing, including other lines of enquiry related to waste repositories and other radionuclides, for example.
- Practical countermeasures in different time perspectives and different terrestrial ecosystems.
- Clarifying current knowledge and identifying research needs through a systematic expert evaluation of all experimental data.
- Collection of strategic data series for model validation.

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Long-Term Dynamics of Radionuclides in Semi-Natural Environments: Derivation Parameters and Modelling (SEMINAT)

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Introduction

During the Chernobyl accident large areas of semi-natural ecosystems were affected by radionuclide deposition. Meadows and forests are typical semi-natural ecosystems. Meadows are used extensively in many countries as pastures for cattle, sheep and goats, while forests are important to man since they provide wood, paper, wild berries, mushrooms, game and recreational areas. Post-Chernobyl investigations have shown that dose to man from semi-natural ecosystems are relatively greater than from agricultural systems and that this dose risk persist for the long-term.

Predictive models are essential to take long-term decisions on the management of contaminated environment and to identify key processes controlling the dynamics of radionuclides inside the ecosystems. During the period following the atmospheric fallout due to the nuclear weapons testing, few models for some specific semi-natural environments were developed. The applicability of these models to a wide range of semi-natural ecosystem is questionable, because in these complex systems it is more difficult to identify general key processes and to apply to other sites models developed for one site.

Studies carried out since the Chernobyl accident have increased the understanding of radionuclide behaviour in semi-natural ecosystems, especially for boreal forests and middle European meadow systems that have been extensively investigated. Data sets have been obtained which describe the distribution and the cycling of radionuclides (especially ^{137}Cs and ^{90}Sr) within these systems. However, predictive modelling has largely been restricted to aggregated transfer factors that provide good contamination estimates, but only for the sites from which data have been obtained directly. There was a need to develop models that can be applied to a broad variety of ecosystems. They are needed for dose estimation, countermeasure implementation and environmental management. They should give reliable estimates of the behaviour of radionuclides in semi-natural systems and of external and internal radiation exposure to man. In order to develop such models it is necessary to understand the basic mechanisms of transfer and migration of radionuclides in meadows and forests.

Objectives

The main aims of the SEMINAT project that was implemented in the 4th framework programme of the European Commission were to increase the understanding of semi-natural ecosystems and at the same time to develop models to predict acute and long-term behaviour of radionuclides in semi-natural ecosystems typical of the EU countries. To achieve these objectives calibration data have been obtained from sites located in the countries participating at the project.

The SEMINAT project has involved field and laboratory activities that have been carried out in parallel with model development. Different experimental areas in forest and meadow ecosystems, covering different soil types and climatic conditions were selected in the countries participating to the SEMINAT project. The specific aims of the project were:

- conceptual models development for forest and meadow ecosystems;
- collection of calibration and validation data in 14 forest sites and in 4 meadows sites selected in Austria, Germany, Ireland, Italy, Switzerland and UK;
- development of **R**adionuclides **i**n **F**orest **E**cosystems (RIFE) suite models;
- development and refinement of models for meadows (**Peatlands** and **Ra**dionuclides **Be**haviour in **S**oil - RABES);
- assessment of the contribution of the different soil type and soil horizons to the caesium content in plants in semi-natural ecosystems;
- development of rapid procedures to quantify the potential transfer from soil to plant;
- calibration and validation of models.

Results

SEMINAT project was designed as an integrated programme of experimental data collection and modelling. The network of forest and meadow experimental sites across Europe was designed to provide information to be employed directly in model calibration.

Model development and experimental activity were associated with laboratory experiments focused to the understanding of the key processes in soil of the semi-natural environments. The soils of the SEMINAT network were investigated to identify the Cs fixation ability of the different soil type and the relation between fixation in soil and root uptake. SEMINAT laboratory experiment results suggested that rhizospheric processes play a key role in the high radiocaesium transfer seen in semi-natural ecosystems. The dominant soils in semi-natural environments in Northern hemisphere are acid, rich in organic matter and/or podzolised, i.e. low radiocaesium interception potential (RIP) soils, in which the competition for radiocaesium between roots and frayed edge sites (FES) promotes root uptake and hence high uptake of radiocaesium by plants.

Forest ecosystems

To calibrate and validate the models developed in the frame of SEMINAT fourteen forest sites were chosen in the project. In 7 of these sites - Lady wood (UK), Buttersteep wood (UK), Roundwood (IR), Tarvisio (I), Weinsberger (A), Kobernausser (A) and Novaggio (CH) - studies on the fluxes of caesium within and

between various ecosystem components have been carried out. In the other forests- Clogheen Wood(IR), Ballyporeen 65 and Ballyporeen 76 (IR), Shanrahan Wood (IR), Hochstadt (D), Siegenburg (D), Garching/Alz (D)- mushrooms and vegetation have been collected in order to derive transfer parameters for model calibration and validation. All experimental data collected in the frame of the SEMINAT project were included in a database that was one of the deliverable of the project.

Experimental data indicate that in the long term the majority of radiocaesium lies within the soil compartment. The amount of total Cs deposition contained within the tree biomass ranges from 2 to 18% across the SEMINAT network of sites with a geometric mean of 5%. Cs activity concentrations in all tree components, with the exception of tree bole bark, are positively correlated to total deposition to soil with significance at the 5% level. Tree components, with the exception of bole bark and bole cambium, are positively correlated with each other with significance at the 1 % level. This last correlation suggests that easily accessible components, as needles, can be used in monitoring activities as an indicator of the activity concentration of the whole tree.

Activity concentrations varied considerably among species of understorey vegetation and in the same species between different years. The between species variability in ^{137}Cs and ^{134}Cs uptake in mushrooms is high at all sites. Between sampling dates individual species from the same site vary, in terms of ^{137}Cs activity concentration by up to 7 times. All data collected show that while the variability is high, certain species tend to take up more Cs than other species. On average symbiotic fungi exhibit transfer parameter which exceed those of saprophytic species by about one order of magnitude. Variability within site and over time within site highlights the difficulty of predicting ^{137}Cs levels in mushrooms and in understorey vegetation on the basis of total soil contamination levels. Investigations carried out in Germany show that the time dependent activity levels in fungal fruit bodies and in understorey plants reflect the activity levels of those soil layers in which the fungal mycelia/fine roots are located. The final structure of RIFE2 model reflects the level of detail required to make such predictions. However, in spite of high values of activity concentration in understorey plants and mushrooms, these forest compartments account for less than 1% of total ^{137}Cs deposition to the sites.

Model development followed the findings of the experimental activity. As a first step a screening model (RIFEQ) was developed. This model allowed the use of preliminary data of each partner's forest sites in a probabilistic uncertainty analysis of radiocaesium distribution in the forest compartments. RIFEQ is an equilibrium ecosystem - level model that takes into account the mass balance of the radionuclides introduced in the system. The input data are the transfer factors and biomass data of each compartment. RIFEQ screening model is useful in assisting with calibration of dynamic forest models, but it does not itself provide a tool for interpreting and forecasting radionuclide behaviour in forest on a temporal basis. For this reason the SEMINAT group has developed a dynamic model capability using, for calibration, data from forest sites within five EU countries. The following dynamic models have been developed and calibrated to allow time-dependent computations of radionuclides in forests following pulse or chronic inputs from the atmosphere;

- RIFE1 (5 compartments dynamic model), originally conceived and partially developed in the frame of ECP5 project was further developed within the SEMINAT group;
- RIFE2 (10 compartments dynamic model), this model consider 6 different soil layers, instead 3 soil layers to take in to account that berries and mushrooms take up radionuclides only from the layers in which mycelia/ fine roots are located.

Meadow ecosystems

Semi-natural meadows include a wide range of ecosystems. In SEMINAT project the following meadows have been considered:

- peatland meadows in Ireland;
- alpine pastures in Germany and Italy;
- highland meadows in Austria.

The highest uptake of ^{137}Cs was recorded in *Caluna vulgaris* from Cavan (IR). This is the dominant vegetation species at this site. All species from Cavan (IR) have a relatively high ^{137}Cs activity concentration with respect to the total deposition to soil, when compared to the values at Spitzweise (A) and in Italy. This difference reflects the difference in soil type at Cavan (IR) compared to the other two sites. Acid, organic peatland soil, such as found in Cavan (IR), is characterised by a high soil to plant transfer. Taking biomass values into account increases the dominance of *Caluna vulgaris* and the importance of dead vegetation as vegetation sinks of ^{137}Cs. At the Cavan (IR) site approximately 10% of total ^{137}Cs deposition is contained within the live and dead vegetation whereas in Spitzweise (A) this value is of the order of 0.1%.

Considering the high variability of radiocaesium concentrations in soils and plants of semi-natural meadows, it was of special interest to investigate the relationship between soil and plant content of radiocaesium in alpine pastures. The presence of such a statistically significant relationship is an essential prerequisite of the soil/plant transfer factor concept assumed in many environmental assessment models to predict the concentration of a radionuclide for a given plant species at an anticipated contamination level of the soil.

In the alpine pastures investigated (Italy and Germany), increased ^{137}Cs plant concentrations were not significantly associated with increased ^{137}Cs soil contents, even though the ^{137}Cs contents in the soil there varied by one order of magnitude and 100 data pairs were assessed in Germany. Obviously, variation in plant communities contributed more to variations in the ^{137}Cs concentration in vegetation than did the ^{137}Cs concentration in the soil. A model based on the soil/plant transfer concept does, therefore, not necessarily provide reliable estimation of the plant radionuclide concentration. If, nevertheless, one decides to utilise the aggregated transfer-factors (T_{agg}) for a site where an association between soil and plant ^{137}Cs contents had not been established, one should at least realise that their use in mathematical ecosystem models may introduce an uncertainty which is very difficult to quantify. This will be especially the case if, from such a pasture, only a few soil and plant samples are taken to determine the transfer factor or concentration ratio.

RABES model has been calibrated in the past with time-series data collected in different meadow ecosystems. In the frame of SEMINAT project the model has been improved and validated with the data collected in Austria and Italy. Peatland meadows are distinct from the

alpine and highland meadows, in that the soil is almost pure organic matter and both the pH and the cation exchange capacity are very low. These characteristics dictate that radiocaesium should have a very high mobility and be quickly lost from the system. In the presence of very low content of clay minerals, in this soil type, radiocaesium may only have a biological sink in this ecosystem. A model was therefore required, independent from RABES, to predict the long-term dynamics of radiocaesium in this ecosystem. The model, PEATLANDS, calibrated with the data collected in Cavan, is able to predict the behaviour of radiocaesium content in sheep meat.

Implications

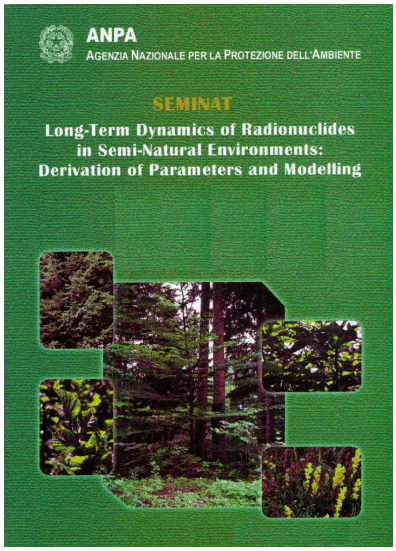
After the Chernobyl accident, it was difficult to define the contribution to the dose to persons from semi-natural environments and to adopt well justified countermeasures, because there was very little information relating to the impact to man of radioactive fallout on forests and semi-natural meadows.

The SEMINAT project considerably improved the knowledge on the key processes that play a significant role in the transfer parameters in semi-natural ecosystems. Dynamic models have been developed that allow time-dependent computations of radionuclide behaviour in forests following pulse or chronic inputs from the atmosphere. These models have been calibrated and validated with data collected in five European countries.

The models developed in the frame of the SEMINAT project are designed to be user-friendly and are coded to function under the Window95 or WindowsNT operating systems.

Through the achievements of the SEMINAT project, in the event of any future accident, the authorities will be able to more rapidly understand and predict the consequences arising from the contamination of semi-natural ecosystems and can consequently make earlier and more realistic decisions on countermeasures and the environmental management of contaminated sites.

IUR members who are interested to receive the final report of SEMINAT project and the CD containing the models are asked to contact Maria Belli (belli@anpa.it)



"Modelling fluxes and bioavailability of radiocaesium and radiostrontium in freshwaters in support of a theoretical basis for chemical/hydrological countermeasures" (ECOPRAQ)

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The acronym of this project, ECOPRAQ, stands for ECOlogical PROcesses in AQuatic systems, and refers, together with the full title of the project, to the process- or mechanistically-based approach to modelling the fluxes and the availability of radionuclides to the biosphere in the aquatic environment. The global objectives of the project, implemented in the 4th framework programme of the European Commission, are the development of mechanistic and generally applicable whole-ecosystem models. Because of their mechanistic basis, these models enable the advancement of a sound theoretical basis for chemical and hydrological countermeasures. The models can also be applied to test the effectiveness of existing countermeasures. The project focuses on radiocaesium and radiostrontium, with emphasis on the former radionuclide, and is broken down into the following six "work packages":

1. Development of mechanistic submodels for the solid/liquid partitioning and (bio)availability of particle-bound radiocaesium and radiostrontium (WP2)
2. Development of mechanistic submodels for the accumulation and elimination of radiocaesium and radiostrontium by aquatic biota (WP3)
3. Development and assessment of chemical and/or hydrological countermeasures (WP4)
4. Development of mechanistically-based whole-ecosystem models (WP5)
5. Model validation of sediment-water exchange and bioavailability of radionuclides in a large-scale controlled laboratory setup and in situ (WP6)
6. Model validation of radionuclide scavenging by suspended particles and uptake by aquatic plants (WP7)

The development of mechanistic submodels for the basic aquatic processes such as partitioning of the radionuclides with inorganic (suspended and sediment) particles, accumulation and elimination by biota, transport processes in lakes/rivers and their catchments, and the incorporation of these basic processes/models in whole-ecosystem models, is organised in the first 4 work packages. Useable versions of these (sub)models are available and presented and discussed in Chapter 3 of this report. It is clearly shown that these models can predict transport (section 3.3), solid/liquid partitioning (section 3.1) and bio-uptake and -elimination (section 3.2) of radiocaesium much more accurately and over a range of very different aquatic environments, compared to the (more empirical) models that were available at the start of the project. This is the case both at the submodel- and at the whole-ecosystem (see section 3.4) level.

The key parameters that affect these basic transport and availability processes have been identified and the (sub)models are tested for systems that span the

range over which these parameters may be encountered in different aquatic environments. Contrary to many earlier projects/studies, all laboratory experiments, large-scale tests, and field measurements have been designed to identify the role of the major environmental variables on basic model-parameters such as the solid/liquid distribution coefficient (K_D), the Concentration Factor (CF), and the rates of radionuclide "fixation"/remobilization by sediments and uptake/elimination by aquatic plants and fauna. All experimental and field data have been collected and interpreted in the framework of the above (sub)models. It is shown that these monitoring data have been used for a successful model-validation and -parameterisation.

Specific achievements of the individual Work Packages are summarised below.

Development of mechanistic submodels for the solid/liquid partitioning and (bio)availability of particle-bound radiocaesium and radiostrontium (WP2)

Mechanistic and mutually consistent equilibrium and kinetic models, and model parameters, have been developed for prediction of radiocaesium mobility (K_D) and exchangeability in aquatic environments. These models are based on the highly selective ion-exchange binding of radiocaesium to the so called "frayed edge sites" on illite clays in soils and sediments. The major ions that compete with radiocaesium for these sites and, hence, are responsible for the variability of the radiocaesium distribution coefficient (K_D) in aquatic systems, are K^+ and NH_4^+. The effect of these key environmental variables on radiocaesium mobility is accounted for in the developed models. The equilibrium model has been successfully tested in this Work Package and in Work Packages 4, 6 and 7. The kinetic model is recommended for predictions of radiocaesium mobility and (rapid) availability, particularly during the first few weeks-months after an accident, and/or when sudden changes in environmental condition are expected (e.g. rapid NH_4^+ production, salinity gradient during estuarine mixing, etc.). The equilibrium model is recommended for predictions of long-term (years) mobility and availability.

Laboratory desorption experiments, after different adsorption times, have shown that radiocaesium desorption is incomplete when induced by high ($>10^{-3}$-10^{-4} M) concentrations of competing (NH_4^+) ions, but is complete when induced by the more environmentally realistic "infinite bath" procedure; experimental artefacts are believed to be caused by (NH_4^+-induced) collapse of the frayed edges of illite clays. It is shown that the commonly applied high-NH_4^+ extractions underestimate truly exchangeable amounts and desorption rates, under environmentally realistic conditions. If practically-applicable, "infinite bath" type desorption procedures are recommended to measure the truly exchangeable amounts of radiocaesium on environmental particles.

Development of mechanistic submodels for the accumulation and elimination of radiocaesium and radiostrontium by aquatic biota (WP3)

Plants:
A mechanistic submodel has been developed for the prediction of the concentration factor (CF) of freshwater plants, as a function of the potassium concentration in the water. The model is based on the Nernst equilibrium equation, for conditions of K^+ sufficiency, and on Michaelis-Menten uptake kinetics for conditions of K^+ deficiency. The model gives a good prediction of CF in simplified mediums for three different plant types: the liverwort *Riccia fluitans*, the rhizophyte *Lemna minor* and the planktonic microalga *Chlamydomonas reinhardtii*.

It is shown that plants submitted to K^+ sufficiency and deficiency exhibit a dual pattern in the regulation of radiocaesium uptake and accumulation. Under K^+ sufficiency, radiocaesium uptake rate and concentration factor (CF) are not affected by pH or the concentration of Na^+ in the medium. In contrast, under K^+ deficiency, maximum uptake rate has been measured under acidic pH, and maximum CF was detected to pH 7.5. Furthermore, under K^+ deficiency, uptake rate and CF increased when the concentration of Na^+ in the medium decreased. Free Ca^{2+} in the medium had a dramatic effect on uptake rate and CF for radiocaesium, both in plants submitted to K^+ sufficiency and deficiency. In the first case, an increase in the external concentration of Ca^{2+} caused a decrease in the uptake rate and CF, whereas under K^+ deficiency an increase in the external ion activity of Ca^{2+} caused an increase in uptake rate and CF. Maximum uptake rate and CF were obtained under conditions of low K^+ and high Ca^{2+}.

Uptake of radiostrontium takes place through Ca^{2+} channels and, in part, through K^+ channels. In the presence of 1 mM Ca^{2+} in solution, uptake kinetics is linear, but in the presence of 10 mM Ca^{2+} uptake kinetics reaches saturation. Inhibition of Sr^{2+} transport by Ca^{2+} is competitive, indicating that plants through the same transport system take up both these ions. Net uptake of Sr^{2+} and CF is low under acidic pH, which is probably due to the enhancement of the efflux mechanism.

In-situ experiments in a lake have shown that the retention capacity for radiocaesium in periphyton decreases exponentially with time along the ecological succession. Retention capacity correlates well with maximum photosynthetic capacity of the periphyton. A significant part of the retention capacity of the periphyton is due to the adhesion of inorganic particles to the living cells. Contamination due to particle adhesion to biota has to be taken into account in the future for a proper understanding of the transfer of contaminants through the aquatic food chain. Work Package 6 has investigated approaches to enable quantification of this effect.

Fish:
The main goal of this part of the project was to study the kinetics of Cs and Sr accumulation by freshwater fish and to develop a dynamic model that can account for the effects of changes in exposure conditions and physiology on the accumulation process. The uptake of the radionuclides by the fish strongly depends on the chemical speciation and some other critical factors such as the hydrogen (pH), potassium and calcium ion activity and water temperature.

The kinetics of Cs and Sr uptake via water and food has been studied under a wide range of conditions and the results fitted to a Michaelis-Menten type uptake model. This model proved an excellent tool to describe, in a mechanistic way, the effects of changes in exposure concentration and other factors on radionuclide uptake. For example, the effect of K and Ca on the

uptake of Cs and Sr is modelled as competition of the metal ions for the same uptake site. In contrast, it is shown that the effects of pH are of a non-competitive nature. The exposure conditions influence both the uptake and elimination of the radionuclides, but the effects are more pronounced at the uptake site. This is because elimination of the radionuclides is, at least to a certain extent, under homeostatic control.

It is shown that a three compartment pharmacokinetic model (one delay and two kinetic pools) is sufficient to describe and predict the uptake and elimination of the radionuclides under a wide variety of exposure conditions. The same model can be used to model radionuclide accumulation at the lower levels of the food chain (see below). The mechanistic concepts and fish models developed form the basis for the submodels used in the whole ecosystem model. These submodels are simplified versions of the detailed fish model and have retained only the most important features (e.g. effect of K on Cs uptake or effect of temperature on growth). The detailed models however, provide the mechanistic rationale on which the whole ecosystem model is based (see Work Package 4 below).

Submodel parameterisation/validation (transfer of radiocaesium and radiostrontium through a trophic chain under well defined laboratory conditions):

The work carried out concerned mainly a laboratory investigation of the effects of key environmental variables on uptake, accumulation and elimination of radiocaesium and radiostrontium in aquatic plants and fish, and on the trophic transfer from plants to fish.

The transport mechanisms of radiocaesium in the microalgae *Chlamydomonas reinhardtii* have been studied through measurement of: (i) Uptake, accumulation and elimination of $^{137}Cs^{+}$ as a function of K^{+} concentration in the water; (ii) Cs^{+} kinetics under deficiency and sufficiency of K^{+}; (iii) Uptake and accumulation of $^{137}Cs^{+}$ as a function of pH. The transport mechanisms radiocaesium in the hydrophyte *Lemna minor* have been studied through measurement of: (i) Uptake and elimination of ^{134}Cs as a function of the external K^{+} concentration and temperature; (ii) Cs^{+} kinetics under deficiency and sufficiency of K^{+}.

The transport mechanisms of radiostrontium (^{85}Sr) in the hydrophyte *Lemna minor* have been studied through measurement of the uptake and elimination as a function of the external Ca^{2+} concentration, with the plant under K^{+} sufficiency and deficiency.

The trophic transfer of radiocaesium (^{134}Cs) and radiostrontium (^{85}Sr) from the hydrophyte *Lemna minor* (duckweed) to the Cyprinid fish *Cyprinus carpio* was studied through measurement of the uptake and elimination kinetics.

These results have been successfully used for the testing of the mechanistic submodels of radiocaesium and radiostrontium transfer to aquatic plants and fish.

Development and assessment of chemical and/or hydrological countermeasures (WP4)

Assessments of the potential effectiveness of aquatic countermeasures must be based on an understanding of the key processes that determine radionuclide transport to and in freshwater systems over long periods of time (decades) after the contamination event. In this project we have developed models for the prediction of changes in activity concentrations of radiocaesium in aquatic systems and terrestrial foodstuffs over these long time-scales.

We have, for the first time, quantified the effect of radiocaesium "fixation" processes on its activity concentrations in the environment. We have further demonstrated that on long time-scales (decades) after fallout the radiocaesium "fixation" process tends towards reversible equilibrium, so that effective ecological half lives of ^{137}Cs tend towards the physical half-life of the isotope, 30 years. By studying radiocaesium (and, to a lesser extent radiostrontium) activity concentrations in 16 European lakes and 10 rivers we have determined the key processes and parameters, which control radiocaesium (radiostrontium) transport in these systems.

This model based understanding has been used to carry out a comprehensive critical review of the effectiveness and applicability of aquatic countermeasures. In the light of the review and a survey of radiation protection organisations, recommendations have been made of ways to improve the response to contamination of aquatic systems. In particular, a lack of working models for predicting contamination was identified.

Development of mechanistically-based whole-ecosystem models (WP5)

In this project we have developed a practically useful overall lake model for radiocaesium, which should be as generally-applicable as possible and based on mechanistic principles. In the search for this model, we have tested many approaches for the description of key processes (e.g., transport from land to lake, sedimentation, resuspension, diffusion, outflow and biouptake). We have delivered an overall model that is far better than anticipated. The new overall ECOPRAQ-model has been validated against independent data for lakes covering a wide domain of lake characteristics, and it has yielded very high predictive power for the target variables, Cs-concentrations in water ($r^2 = 0.92$) and fish ($r^2 = 0.98$). Practical usefulness in contexts of lake management and research involves at least three things: high predictive power (otherwise the simulations are mere theoretical exercises), easy access to the necessary driving variables, and a wide applicability. This model probably meets these three requirements better than any other model, not just for radiocaesium but also for water pollutants in general.

A crucial element in the derivation of the radiocaesium model for lakes has been to find the most relevant general structure and the best possible equations related to this structure, which can handle the most important fluxes of radiocaesium to, from and within lake systems. This model also meets two requirements that may seem contradictory: few and readily available driving variables, and a relevant general ecosystem structuring to handle all important radiocaesium fluxes. Solving this paradox is the key to the predictive success of this lake model.

The ECOPRAQ whole-lake model handles the following biotic processes: fallout on the lake surface and catchments area, transport from catchments area to lake, transport in dissolved and particulate phases,

sedimentation, internal loading (advection and diffusion), transport to passive (geological) sediments, perturbation (mechanical mixing) and outflow. The following biotic processes are covered: Biouptake, excretion, biomagnifications, feeding habits, temperature dependencies, fish weight dependencies, biological dilution, and radiocaesium uptake by cells and competition with potassium. In spite of the fact that all these processes and mechanisms are accounted for, the model is driven by just a few readily available variables, like latitude, altitude, catchments area, characteristic soil type, lake area, mean depth and K-concentration. Such data are generally available for lakes from standard monitoring programmes. Many of the structures, sub-models and equations are general in the sense that they apply to other water pollutants than radiocaesium and to other aquatic systems than lakes.

Model validation of sediment-water exchange and bioavailability of radionuclides in a large-scale controlled laboratory setup and in situ (WP6)

The processes governing the transport of radiocaesium between agrochemical and biological compartments of a river ecosystem have been studied by means of large-scale controlled laboratory experiments, where the relevant key parameters for sediment-water exchange and bioavailability were monitored and quantified.

Passive Diffusion Experiments have shown that the diffusion processes of radiocaesium are largely dependent on the type and amounts of captions in the water phase, which compete with radiocaesium for exchange with binding sites in the sediment. Running Water Experiments have shown that transport of radiocaesium fixed to suspended particles is a significant source for the radiocaesium uptake in biota in situations where contaminated sediments are eroded by running water.

Data from the passive diffusion experiments have been modelled using a numerical solution to the advection-dispersion equation where radiocaesium is released from sediments by diffusion through the sediment pore waters and across the sediment-water interface. In order to account for the effect of the different types and concentrations of cations in the experimental runs on radiocaesium mobility, the model incorporates a radiocaesium K_D that is calculated according to the equilibrium ion-exchange model developed in Work Package 2. Model predictions show excellent agreement with the observed changes in ^{137}Cs activity concentrations over the period of the experiments. The tests were carried out on two very different sediment types (one mineral, one organic) and for very different water conditions (both fresh water and salt water). This successful test of the model will allow its use to assess the importance of remobilization to radiocaesium contamination of surface waters in a wide range of different aquatic systems.

Model validation of radionuclide scavenging by suspended particles and uptake by aquatic plants (WP7)

Field experiments have been performed to test the role of benthic algae (periphyton) in trapping inorganic suspended solids transported by the river water and to discriminate between the caesium content of periphyton caused by the adherence of inorganic solids and by the active uptake inside the organisms. Periphyton was allowed to develop on artificial substrates, which were vertically suspended in the river water. The contribution of caesium in suspended solids adhering to biotic surfaces was estimated by determining the scandium content (so called scandium method).

The scandium method was used because this element is geologically ubiquitous in soils and plants and other organisms do not actively take it up. The mass of suspended particles retained on the surfaces of algae growing on submerged substrates has been determined by comparing the scandium content of suspended material with that in algal communities. Neutron activation analysis was used as the analytical method for determination of scandium, as well as caesium.

It is shown that the retention of suspended particles, transported by river flow, on the surfaces of freshwater plants is a potentially important process in the contamination of aquatic biota. The results indicate that the suspended particle fraction can contribute up to 80% of the caesium contamination of periphyton samples. Active caesium uptake and accumulation by aquatic biota represents the remaining 20% of the total caesium contamination. It is shown how this approach allows periphyton to be used as a model for phytoplankton. The data have also been successfully used to validate the submodels for both concentration factor (CF) of aquatic plants and K_D of the riverine suspended particles.

IUR members who are interested to receive the final report of ECOPRAQ project are asked to contact Rob Comans (comans@ecn.nl).

Preliminary Announcement

The 5th International Conference on Environmental Radioactivity in the Arctic and Antarctic

St. Petersburg, Russia

June 16 – 20, 2002

The conference will be organised by Norwegian Radiation Protection Authority (NRPA) and Russian Federal Service of Hyrdrometeorology and Environmental Monitoring (ROSHYDROMET) in association with IUR and AMAP

Optimization in Radiation Protection, 13-15. November, 2000

Workshop in Veszprém, Hungary

Organizers:
University of Veszprém Department of Radiochemistry (Veszprém,Hungary) and Nuclear Power Plant Department of Radiation Protection (Paks, Hungary)

Sessions and preliminary presentations:

Monetary value of the person-sievert

L. Eeckhoudt (Univ. Mons, B): Introduction to the monetary value
C. Shieber, et al (CEPN, F): Models developed to assess the monetary values of person-sievert for public and workers
K. Eged, et al (Univ. Veszprem, H): Assessments of the monetary values of person-sievert in Hungary

Additional lectures and discussion on the monetary values of the person-sievert (guided by: L.Eeckhoudt)
In order to guide the discussion, several topics could be proposed, with brief presentations:

- Practical use of the monetary value of the man-sievert,
- International comparison of the monetary value of the man-sievert
- The evolution of the values according to economic criteria and to modifications of individual dose distributions

Optimization in occupational radiation protection (mainly NPPs)

I. Malatova, Z. Prouza (NIRP, CZ): Optimization in occupational radiation protection, in Czech Republic
G. Volent et al. (NPP Paks, H): Optimization in the NPP Paks, Hungary
Z. Kis et al (Country Hosp. Veszprém, H): Examples on the individual doses and costs of radiation protection a nuclear medical laboratory

Optimization in public radiation protection (remediation of radioactive contaminated areas etc.)

D. Oughton et al (Univ. Agriculture, No): Ethical issues in optimization of radiation protection
J. Brown (NRPB, UK):

- Intervention for recovery after accidental relea ses of radionuclides for protection of the public,
- NRPB/UK philosophy on intervention for recovery after accidents,
- recoverycountermeasures: decontamination and restricted access measures- issues concerning the implementation of these measures including dose saving, costs, waste, feasibility and acceptance.
- B. Kanyár et al. (Univ. Veszprem, H):
- Costs and averted doses of the remediation procedures in the environment of the U-mine in Hungary
- J. Somlai et al. (Univ. Veszprém, H):
- Optimization of measures to reduce the external dose from building material in dwellings

The afternoon sessions are mainly for discussion of problems.

The presentations, including the detailed contributions of the discussions, will be issued in Workshop proceedings.

Local responsible:
Ms. Katalin Eged
Tel./fax: 00-36-88-427681
E-mail: egedk@almos.vein.hu
Address: University of Veszprém Dept. Radiochemistry, Building A
8200 Veszpém, Egyetem u. 6-10. Hungary

Cost of staying in Veszprém:
Hotels: 25-55 USD/night/person (2,3,4 *s), 50-100 USD for higher quality
Full board : Hotel + 30-50 USD/day/person, incl. local travelling etc.

Nomination to the meeting and Hotel reservations are to be asked before the 30th of October.

Béla Kanyár

IPSN organise

Radioécologie/écotoxicologie des milieux continentaux et estuariens

Palais des congrès
Aix en Provence, FRANCE
3 - 7 Septembre, 2001

Rationale:

Since the early forties radioecology has, often in an emergency situation, been faced with the need to evaluate the impact that the military or the civilian use of nuclear energy has had on the environment. It forms part of the development of ecology; over time and together with ecotoxicology, laboratories have been trying to understand the processes of the transfer of radionuclides and to integrate them as much as possible in engineering techniques. Within this context, the idea of sustainable development is essential and radioecology enables us to move forward along this path. It has also contributed to the recognition of a second key idea, precautionary principle. The environment constitutes its very field of application. On the threshold of the 21st century radioecologists need to take stock of the situation and to widen perspectives. Hence, beyond the discussions and the exchange of essential up-to-date scientific and technical information, the aim of this congress is to review the state of the art and to define the research themes for the coming years.
The oral sessions will be devoted to invited presentations followed by contributions chosen on the basis of their broad scope. The posters will promote communication between participants and will deal with more specialized results. A camera-ready text will be required for every presentation.
The whole course of the congress will be in French and in English with on-line translation

Contact:

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SETAC Europe

11th Annual Meeting
Madrid, Spain
6-10 May 2001

Call for Abstracts

From Basic Science to Decision-making «The Environmental Odyssey»

ABSTRACT DEADLINE: 3 NOVEMBER 2000

Scope of the Meeting

In the second half of the 20th Century simultaneously with an extraordinary increase in the analytical capacity of environmental chemistry and toxicology concerns were raised about environmental pollution. We have produced a considerable body of data, although we must also recognise that our level of understanding of cause and effect is less impressive. We have also learned an important lesson: we know that it is no longer scientifically acceptable to work with one hundred thousand industrial chemicals, including several thousands pesticides, biocides, veterinary pharmaceuticals, and other biologically active substances, using a pure chemical approach.

The 21st century begins with a major challenge for us all. Chemical, biological and ecological tools must be combined to produce reliably working approaches. This meeting will try to promote the integration of different areas of science and technology to produce basic scientific knowledge and scientifically sound decision-making tools. These include screening and cost/effective analytical tools for control and monitoring, integration of ecotoxicity-based methods in Risk Management and Life Cycle Assessment, combined Quantitative Hazard Assessment for complex industrial emissions; development of comparative Ecological Risk Assessment methods for pesticides, biocides and radionuclides, and development of tools to prioritise and integrate approaches to assess the environmental consequences of human activities. Other innovative proposals will also be welcome. The challenge is to deal with the future. To discuss what we have and what we need, and to foresee how we can combine scientific knowledge, technological development and regulatory compliance to develop an Environmentally Sustainable Development of the Earth in the next century. The 21st century Odyssey for environmental toxicologists and chemists begins in Madrid in May 2001

PLENARY, KEYNOTES AND SPECIAL ACTIVITIES

There will be a plenary speaker at the opening ceremony and keynote speakers on the following three days. In addition, to platform and poster sessions, a set of special

activities will be run during the meeting. These activities will include debates, round-table discussions, and a special Symposium on the "Aznalcollar Accident, Spain" as a case study for risk assessment of areas of high ecological value.
Joint activities with the International Union of Radioecology are also being scheduled!

These joint activities are the inclusion of one session on radioecology and the organisation of a Workshop entitled:

Comparison and harmonisation of remediation strategies used in radioecology and in conventional environmental pollution

The chair of these sessions will be held by Dr. Gabriele Voigt, GSF, Neuherberg, DE (voigt@gsf.de), from whom more detailed info can be collected, and the president of the IUR, Dr. Gilbert Desmet, Zemst, BE (gilbert.desmet@skynet.be).
.
Visit also the IUR Website and the SETAC Website for the master info regarding the SETAC Annual Meeting!

http://www.iur-uir.org
http://www.setac.org

INTERNATIONAL CONFERENCE ON RADIOACTIVITY IN THE ENVIRONMENT

2-5 September, 2002
Principality of Monaco

The Journal of Environmental Radioactivity (JER), in association with the International Union of Radioecology (IUR), the International Atomic Energy Agency's Marine Environment Laboratory (IAEA-MEL) and Elsevier Science Ltd, is pleased to announce a major international conference on Radioactivity in the Environment. The conference is expected to be the most significant of its kind ever held and is also being sponsored by .....

Like JER itself, the conference will celebrate the science of all aspects of the study of environmental radioactivity, from the use of radionuclides as tracers and timers of natural processes to the radiological assessment and remediation of their anthropogenic occurrence as environmental contaminants. On the one hand, whole fields of science have depended, and indeed still depend, on the unique kinetics and sensitivity of detection of radioactive decay for understanding of their time-scales and mechanisms. On the other, radioactive contamination from a range of man's activities has for a century occupied the attention of the scientific community, which has extensively studied its environmental pathways and health effects, without always communicating effectively with society, which still fears radioactivity more than any other contaminant. This conference, besides taking a broad scientific view of its field, will also feature focussed special sessions on current and future "hot topics". The conference will mark 20 years of the Journal of Environmental Radioactivity and will be held in Monaco where it began. The scientific committee for the conference is in essence the international Editorial Board of JER, plus representatives of the major co-organisors, and the "hot topics" thus far identified for special emphasis are:

- *Remediation & restoration of contaminated ecosystems*
- *Health effects of environmental radioactivity for flora and fauna*
- *Advanced analytical methods: and their latest applications to the earth & environmental sciences*
- *Tracers of the ocean's carbon cycle*
- *Microbiological cycling of radionuclides*
- *Radioactivity in; extreme environments; subtropical and tropical environments; forest ecosystems; the Arctic; S E Asia (priorities therein)*
- *Speciation of radionuclides*
- *Radioactive aerosols*
- *Modelling environmental transport of radionuclides*
- *Modelling and risk assessment*
- *Technologically enhanced radioactivity from non-nuclear industries*
- *Public perceptions of environmental radioactivity*

3rd INTERNATIONAL CONFERENCE

of Balkan Environmental Association on

TRANSBOUNDARY POLLUTION

Organized by:
Balkan Environmental Association (Â.ÅÍ.Á.),
Co-organized by:
Union Gen. of Romanian Industries (UGIR-1903)
Romanian National Oil Company-PETROM
Public Power Corporation of Greece (PPC)
In collaboration with:
Ministry of Waters, Forests and Environmental Protection of Romania

SECOND CIRCULAR

23-26 November 2000
"PATRIARCH PALACE"
Bucharest - ROMANIA

IN COLLABORATION WITH:

European Commission-Environment Institute JRC-Ispra/ Italy, - Institute of the Natural Resources and Agrobiology of Sevilla (CSIC)/Spain, - Mediterranean Scientific - Association of Environmental Protection (MESAEP) - Marine Research Institute (NIMRD), - National Research Institute for the Danube Delta (INCDD), - National Institute for Marine Geology and Ecology (GEOECOMAR), - National Institute for Environmental Engineering (ICIM), - Polytechnic University of Bucharest, - Romanian Union of Chemists, - Greek Union of Chemists, - Bulgarian Union of Chemists, - Albanian Union of Chemists, - Institute Atomic Physics of Bucharest (IFA)

Secretariat

The Conference Secretariat is at the National Research and Development Institute for Industrial Ecology «ECOIND» - Sos. Panduri 90-92, sect.5, 76231 Bucuresti - ROMANIA; Phone:*40.1.410.67. 16,* Fax: *40.1.410.05.75;*

Email: *icpear@sunu.rnc.ro.*

Contact person: Felicia TOADER, Phone *40.1.410.03.77/155.*

Web site:
www. teithe.gr/Academßc/Research/Bena/index htm

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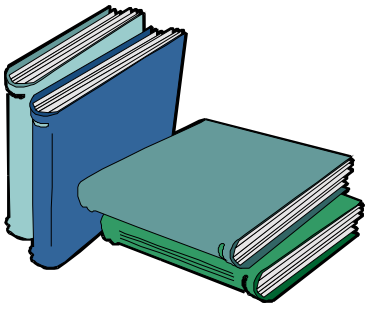

A monograph by A. Shcheglov

"Biogeochemistry of Technogenic Radionuclides in Forest Ecosystems: a 10-year Study in the Territories Severely Contaminated due to the Chernobyl Accident."

has recently been published in Moscow (NAUKA, 1999, 267 pages, 87 Tables, 97 Figures, in Russian)

An extended **English edition** of this monograph is now in preparation.

Author:

Alexey Klyasthorin

The monograph considers in detail the fate of Chernobyl-born radionuclides (^{137}Ñs, ^{90}Sr, $^{238-240}$Pu, ^{106}Ru, ^{144}Ce etc.) in natural and seminatural environments of Ukraine, Belarus', and European part of Russia with the emphasis on forest ecosystems. The analysis is based on the long-term (over 10 years) monitoring studies carried out in various forest and meadow ecosystems at the distance of 4 to over 500 km from the Chernobyl Nuclear Power Plant.

The obtained data elucidate basic processes of radionuclide migration and accumulation in the soils, arboreal and herbaceous vegetation, and fungi. The book contains unique data on the dynamics of radionuclide content in and redistribution among various components of natural ecosystems. Present approaches to modelling of radionuclide migration in forest environments are discussed. The scale and rate of the long-term radionuclide redistribution in the system of geochemically-joint landscapes are estimated.

The monograph is intended for researchers engaged in radioecology, impact and behaviour of trace elements, environmental pollution, and modelling.

Presently we try to estimate the minimum circulation of the book. If you or your colleagues are interested in getting the monograph, please send your requests to the following addresses:

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