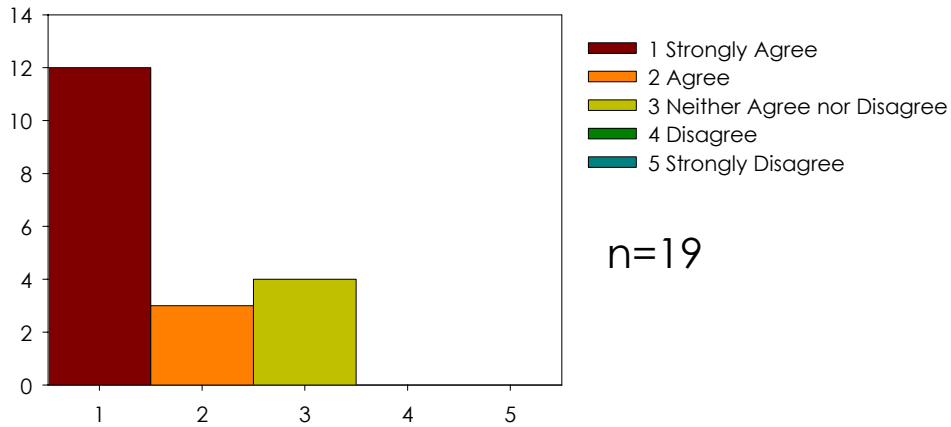


## **Appendix 1**

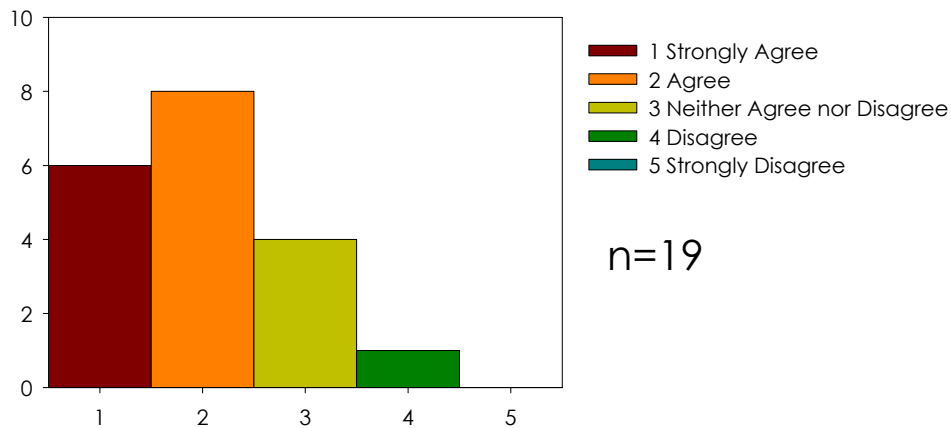
### **Knowledge Gaps and Issues in Environmental Multipollution Research**

**Full Breakdown of Responses**

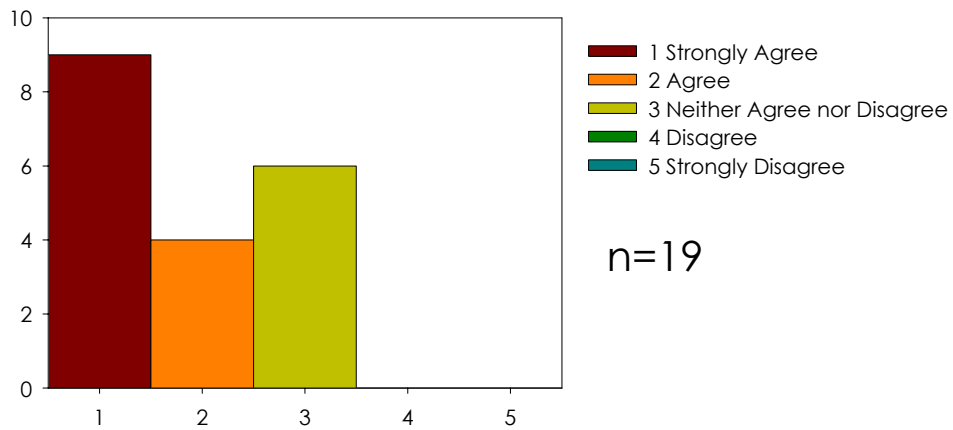
**Q.1 We need to better understand how the multipollution context affects the behaviour of a single pollutant (e.g. migration, bioavailability of U where there are other chemical contaminants present).**



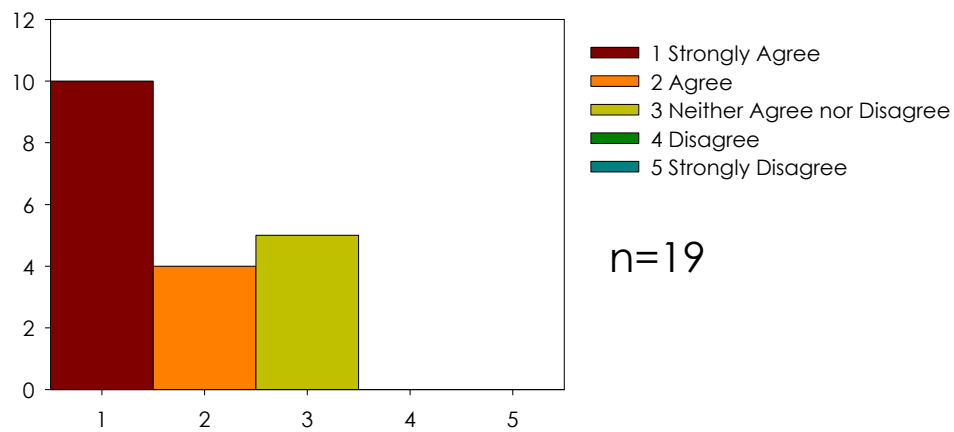
**Q.2 We need to investigate how environmental parameters affect the behaviour of multiple stressors in order to propose the most adequate remediation strategies.**



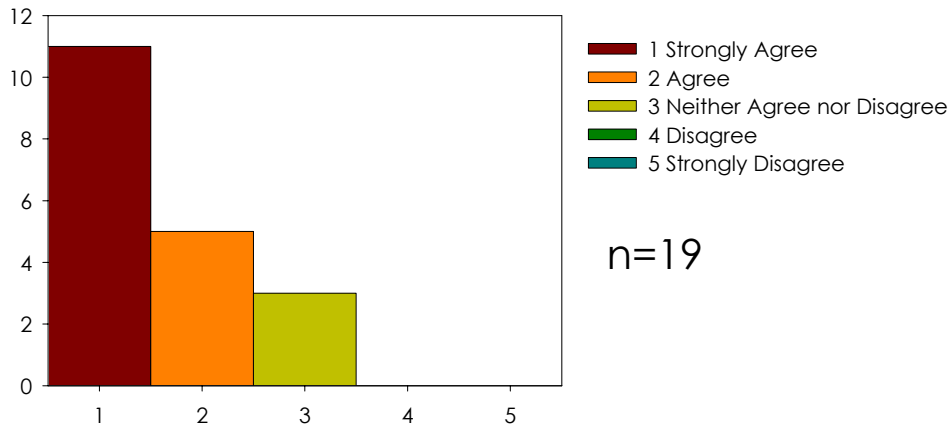
**Q.3 We rely too much on single pollutant scenarios in contaminant behaviour studies.**



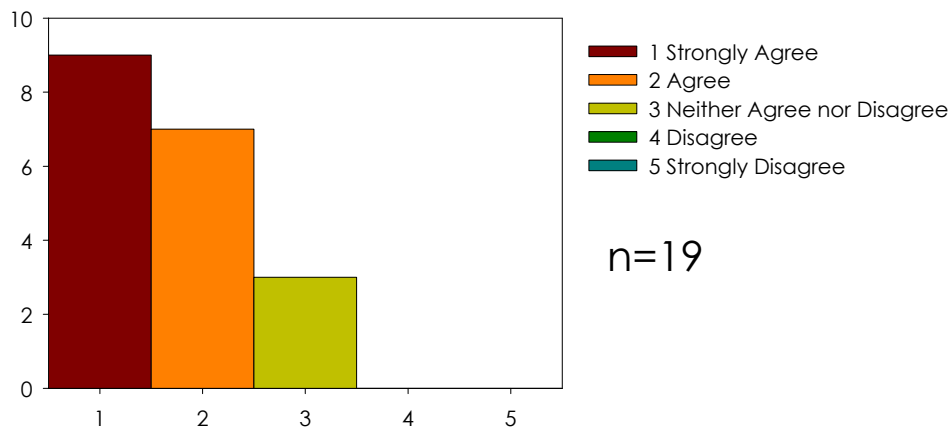
**Q.4 We rely too much on single stressors exposure experiments.**



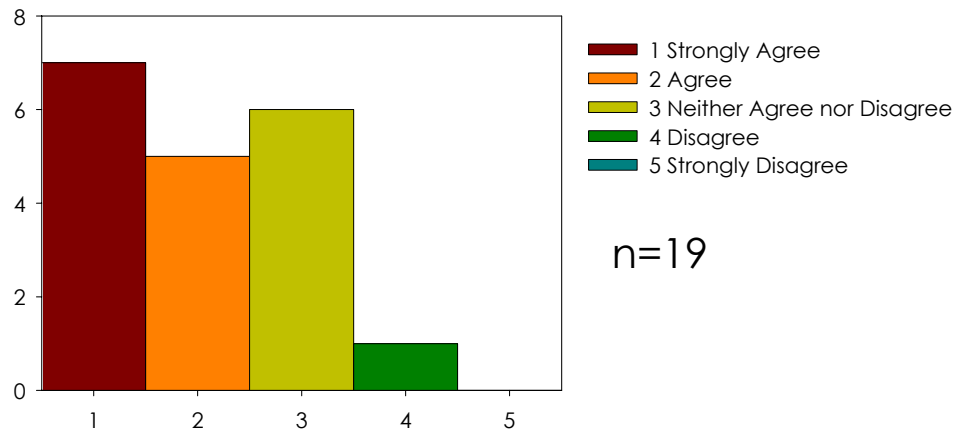
**Q.5 We need to investigate additive and synergistic effects.**



**Q.6 We need to consider the ecological response of biota to both radioactive and non-radioactive chemical stressors.**



**Q.7 We need to better understand and estimate uncertainties in a multipollution context.**



## **Appendix 2**

### **Research Interests, Capabilities, and Facilities**

## Argonne National Laboratory

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## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

**Details of experience and strengths on transfer processes:**

We've assessed risks at sites contaminated with chemicals and radionuclides as part of the cleanup of Cold War legacy sites, beginning in the late 1980s. We also assess acute releases of mixed contaminants. Evaluating environmental fate/transfer processes is a key component of these analyses, including to address partitioning, determine what secondary contaminants may form, and indicate what is likely to coexist spatially and temporally -- to help focus the mixtures risk assessment. Note that these evaluations done in an office setting rather than as field or laboratory experiments, although in some cases they are conducted at the field site in coordination with the individuals collecting the data. Health risks estimates have been the main focus, including via the food chain. However, previous experience was in a laboratory setting, involving growth chamber and hydroponic uptake studies and controlled outdoor terrestrial experiments (radium/radon, uranium mill tailings).

**Ecosystem types: Terrestrial (T); Freshwater (F)**

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** Yes

**Details of experience and strengths on multipollution effects:**

We evaluate how the following can affect migration and bioavailability: characteristics of (1) the facility/site (including past and ongoing processes and control features), (2) the environmental setting, and (3) the specific chemicals and radionuclides present (e.g., their form/matrix and speciation and the presence of other chemicals/substances). As noted above, these risk assessments synthesize and evaluate data collected by others from both field experiments and controlled environments (the latter notably for the animal toxicology data) to estimate risks in order to inform health protection/environmental cleanup decisions.

**Contaminants: Heavy Metals; PAH's; PCB's; Pesticides; Radionuclides; Other Details of working with contaminants**

(Have limited experience with evaluating dioxins/furans, as part of the suite of contaminants associated with specific facilities, and as the basis of the TEF/relative potency approach for assessing mixtures.) Have also assessed solvents/volatile organic compounds and certain anions

(e.g., nitrate, fluoride, chloride). Also interested in the role of microorganisms on fate/transport (e.g., solubilization in the root zone) and microbial contamination.

**Ecosystem types: Terrestrial (T); Freshwater (F)**

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

**Experience and strengths in studies on radiation transfer on organisms:**

We have evaluated the bioaccessibility/bioavailability and transfer within the food chain, and have emphasized the toxicokinetics (absorption, distribution, metabolism, and excretion) in humans. This has been done for a set of chemicals and radionuclides as part of the risk evaluations for contaminated sites and facilities, and more extensive evaluations are being conducted for an ongoing study of air and drinking water that could be contaminated by multiple substances.

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** Yes

**Experience and strengths on multipollution effects:**

We are evaluating the joint toxicity (including synergistic effects) of various chemicals and a limited set of radionuclides, for humans.

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** No

**Experience and strengths on capability to conduct studies:**

Our division does not have laboratory facilities, but we could collaborate with others to conduct integrated studies. (In fact, we have submitted proposals for internal research funding to do this, but the proposed joint laboratory setting/risk assessment studies have not yet been funded.)

**Organism types:**

*Terrestrial:* Mammals, humans (terrestrial & fresh water can apply, for food chain, air, & drinking water)

**Contaminants: Heavy Metals; PAH's; PCB's; Pesticides; Radionuclides; Other**

**Details of working with contaminants**

As noted in the companion form, we have limited experience with dioxins/furans, we also assess volatile organic compounds/solvents and selected anions, and we are also interested in microbes.

**Biological effects studied with respect to the effect of multipollutants on biota:**

Cancer (broadly), and combined organ/system effects (blood/hematopoietic, gastrointestinal, bone/skeletal, neurological, cardiovascular, hepatic, urinary/kidney, reproductive, developmental, and others).

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

**Details:** Double yes! Environmental risk assessments are what we do, and we would really love to share approaches and ideas for effectively assessing multiple radioactive and nonradioactive contaminants, exposures, and effects (over time).

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

Our division does not conduct laboratory experiments -- we evaluate the data collected by others, for incorporation into risk assessments.

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:** As above.

**Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:** As above.

## Belgian Nuclear Research Centre

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### Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

**Details of experience and strengths on transfer processes:**

Uptake of RN and HM from soils contaminated by the NORM industry. Role of phytochemistry and speciation on uptake and repartitioning. Comparison of effect of U and Cd on bioindicators.

**Ecosystem types: Terrestrial (T)**

**Experiment types: Controlled Environment**

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** Yes

**Details of experience and strengths on multipollution effects:**

Comparison of uptake of U in different multipollution contexts Mostly potted soil experiments to study of effect of physicochemistry and co-contaminants on uptake of U

**Contaminants: Heavy Metals; Radionuclides**

**Ecosystem types: Terrestrial (T)**

**Experiment types: Controlled Environment**

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

**Experience and strengths in studies on radiation transfer on organisms:**

Transfer of U to plants from soils contaminated by NORM-industry activities. Co-contamination of HM and As

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** Yes

**Experience and strengths on multipollution effects:**

We performed research on comparison of biological effects induced following exposure to U and Cd on some bioindicators mainly linked with for *Phaseolus vulgaris*. Work will be continued with *Arabidopsis thaliana*. Biomarkers are/will be biometric, reproduction, linked with oxidative stress defence mechanisms.

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** Yes

**Experience and strengths on capability to conduct studies:**

Potential to expose plants to low-dose long-term (life cycle) gamma radiation in combination with internal exposure to radionuclides and HM

**Organism types:**

Terrestrial: Plants

**Contaminants: Heavy Metals; Radionuclides**

**Biological effects studied with respect to the effect of multipollutants on biota:**

Stress enzyme expression stress affected etabiolites protein patterns and levels (in collaboration) comet assay gene expression ( in collaboration with U Hasselt, Belgium)

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

**Details:**

No research done so far in multipollution context but interest

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

Virtually all infrastructure for analysis of radionuclides and different sources of radiation

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

ICP-MS, AAS, XRD, HPIC, HPLC

**Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:**

PCR, micro array, cell fluorimetry, spectrophotometry, comet assay, proteomics

## Centre for Ecology and Hydrology

Centre for Ecology and  
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## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

### Details of experience and strengths on transfer processes:

Terrestrial ecosystems, general transfer to environmental components, to man and to biota

**Ecosystem types: Terrestrial (T); Freshwater (F)**

**Experiment types: Controlled Environment; Field**

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** Yes

### Details of experience and strengths on multipollution effects:

Animal radioecology, countermeasures, arctic, speciation in animals

**Contaminants: Dioxins; Heavy Metals; Pesticides; Radionuclides**

**Ecosystem types: Terrestrial (T); Freshwater (F)**

**Experiment types: Controlled Environment**

### Organism types:

*Terrestrial:* Amphibians, Birds, Mammals, Plants, Soil Fauna

## **Radionuclide (and other contaminants) Effects**

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** No

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** No

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** No

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** No

## **Facilities**

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

UCAS accreditation applied for low level radioanalysis of beta, gamma and alpha

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

UCAS accredited for wide range of ecologically relevant analyses

**Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:**

Microbiological expertise in CEH effects analysis for other contaminants (e.g. organics) by other parts of CEH

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## Radionuclide (and other contaminants) Transfer

*Conduct studies on transfer processes in environment in a multipollution context* No

*Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:* No

*Contaminants: Heavy Metals*

*Ecosystem types: Marine (M); Freshwater (F)*

*Experiment types: Field*

## Radionuclide (and other contaminants) Effects

*Conduct studies on radionuclide transfer to organisms in a multipollution context:* No

*Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):* No

*Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:* No

*Contaminants: Dioxins; Heavy Metals*

*Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:* No

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## Democritus University of Thrace

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skoutrou@agro.duth.gr

## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** No

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** No

### Contaminants: Pesticides

#### Details of working with contaminants

Pesticides generally are considered to be multipollutants, due to the diversity of their chemical structure, mode of action and physico-chemical properties. Therefore strong antagonistic or synergistic effects are encountered. We work nearly exclusively with pesticides, but not in a multicontaminant sense with radionuclides.

**Ecosystem types: Terrestrial (T); Freshwater (F)**

**Experiment types: Controlled Environment; Field**

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** No

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** No

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** Yes

### **Experience and strengths on capability to conduct studies:**

My main experience is on pesticides toxicity on plants and secondarily on fish. Field and laboratory facilities are available regarding plants. As far as aquatic organisms are concerned, pesticide toxicity on *Gambusia affinis* is currently monitored.

### **Organism types:**

Terrestrial: Plants

Freshwater: Fish

### **Contaminants: Pesticides**

#### **Details of working with contaminants**

Pesticides are generally regarded as multipollutants, due to their huge variation in chemistry, mode of action and physical properties. Synergism or antagonism in toxicity is not adequately studied and would be of interest.

#### **Biological effects studied with respect to the effect of multipollutants on biota:**

We are currently working on: Fish toxicity through pesticide mixtures; Weed Response to herbicides; Plant Growth manipulation through plant growth regulators. We are interested in :Ache inhibition on fish

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** No

#### **Details:**

Though ERA has not yet been conducted, I would be very much interested to contribute in a comparison of approaches in environmental risk assessment for pesticides and radionuclides

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

None

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

None

**Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:**

Conventional chemical laboratory (Spectroscopy, gas chromatography, electrophoresis)

## ECOMatters Inc.

ECOMatters Inc.  
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## Radionuclide (and other contaminants) Transfer

*Conduct studies on transfer processes in environment in a multipollution context*

Yes

*Ecosystem types: Terrestrial (T)*

*Experiment types: Controlled Environment; Field*

*Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:*

Yes

*Contaminants: Heavy Metals; PCB's; Radionuclides*

*Ecosystem types: Terrestrial (T)*

*Experiment types: Controlled Environment*

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** No

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** No

**Organism types:**

Terrestrial: Plants

**Contaminants: Heavy Metals; Radionuclides**

**Biological effects studied with respect to the effect of multipollutants on biota:**

Endpoints that affect populations

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

None, we use commercial labs

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

Ditto

## Environment Agency

Environment Agency  
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## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

### Details of experience and strengths on transfer processes:

As an multi -faceted organisation which has environmental protection at it's heart the Agency undertakes a number of studies both in -house and through externally let contracts in the transfer of environmental contaminants in the environment. This ranges from studies on PCBs and other organic chemicals into birds and other species through to studies on radionuclide transport in the environment. Approaches used include experimental, fieldwork and modelling. The Agency has a national laboratory service for undertaking the analysis of non -radioactive contaminants and it has agreements with a number of laboratories for undertaking the analysis of radionuclides in different media including water, soil, sediment and biota.

**Ecosystem types:** Terrestrial (T); Marine (M); Freshwater (F)

**Experiment types:** **Controlled Environment;** Field

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** Yes

### Details of experience and strengths on multipollution effects:

See previous response.

**Contaminants:** **Dioxins; Heavy Metals; PAH's; PCB's; Pesticides; Radionuclides**

### Details of working with contaminants

The Agency is responsible for regulating processes that involve or give rise to all of the contaminants mentioned and therefore has an interest in all of these.

**Ecosystem types:** Terrestrial (T); Marine (M); Freshwater (F)

**Experiment types:** **Controlled Environment;** Field

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** No

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** Yes

**Experience and strengths on multipollution effects:**

The Agency has biology laboratories which undertake routine ecotoxicological assessments for chemicals together and in isolation. The Agency's National Laboratory Service has the capability to analyse the majority of non-radioactive contaminants and there are agreements in place with external laboratories to undertake the analysis of radioactive contaminants.

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** Yes

**Experience and strengths on capability to conduct studies:**

We have an ecotoxicology laboratory that can and does undertake assessments of mixtures of chemicals but not of radionuclides. This would be done in collaboration with other laboratories that have the appropriate facilities.

**Organism types:**

*Terrestrial:* Crustaceans; Invertebrates

*Marine:* Crustaceans; Fish; Invertebrates; Molluscs

*Freshwater:* Crustaceans; Fish; Invertebrates; Molluscs

**Contaminants: Dioxins; Heavy Metals; PAH's; PCB's; Pesticides; Radionuclides**

**Details of working with contaminants**

The Agency regulates processes that give rise to or discharge all of the above contaminants and therefore has an interest in them all.

**Biological effects studied with respect to the effect of multipollutants on biota:**

A range of ecotoxicological endpoints including but not limited to: LD50 studies, Reproductive effects and field based assessments using but not limited to earthworm survival and reproduction bait lamina

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

**Details:**

Multimedia/source authorisations and permissions are given out by the Agency and require the assessment of both radioactive and non-radioactive pollutants. These are undertaken on a regular basis and require underpinning science (from the applicant and the Agency) to be evaluated by Agency staff.

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

No in house radioanalytical facilities available although arrangements exist for getting analytical work done in external accredited (to ISO17025) laboratories.

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

The Agency's National Laboratory Service provide a large amount of the Agency's environmental data which supplements that obtained from continuous monitors, other agencies and industry. We can analyse samples from a wide range of matrices, including: \* Fresh and saline waters \* Sewage and industrial effluents \* Leachates \* Plant and animal material \* Soils and sediments \* Coal, slags and deposits \* Industrial wastes (including asbestos) \* Ash \* Gases Analysing: \* Inorganics Analysis of many inorganic substances used to determine general water quality including: Biochemical Oxygen Demand, Chemical Oxygen Demand, nutrients and cyanide. \* Organics Applications available for pesticides, herbicides, volatile organic compounds, endocrine disrupters and investigative mass scans. \* Metals Variety of applications covering Mercury, Lead, Cadmium, Arsenic and a general range of metals. \* Dioxins Specialised facility offering low level Dioxin and PCB analysis in a range of matrices. \* Waste In addition to analysing industrial waste and contaminated land samples (e.g. asbestos, landfill, gas) we also offer sampling, waste classification, auditing and data interpretation.

***Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:***

\* Microbiology Comprehensive bacteriological service including *Salmonellae*, *Clostridium* and *Legionella* testing and risk assessment, together with a specialist virology section. Fully equipped ecotoxicology laboratory

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## Enviros Consulting Ltd

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Assessment  
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### Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

**Details of experience and strengths on transfer processes:**

Borehole installation and sampling of groundwater for pollution of metals, persistent organics, etc. to identify contaminant migration and hydrogeochemistry. Environmental sampling of water, freshwater and marine sediments and soil and biota from terrestrial environments again to assess a range of contaminants. Field investigations predominantly related to site investigations and remediation.

**Ecosystem types:** Terrestrial (T); Marine (M); Freshwater (F)

**Experiment types:** Field

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** No

**Contaminants:** Heavy Metals; PAH's; PCB's; Radionuclides

**Details of working with contaminants**

All of the above associated with a wide range of site investigations relating to the management and remediation of contaminated sites. Sites that include former steel works, MOD defence estate sites, oil refineries and other industrial sites, nuclear licensed sites, and other sites where radioactive materials have been maintained and have led to land contamination.

**Ecosystem types:** Terrestrial (T); Marine (M); Freshwater (F)

**Experiment types:** Field

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** No

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** No

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** No

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

### **Details:**

As a major environmental consultancy we routinely undertake assessments in support of RSA authorisations (doses to biota) or EIAs associated with planning applications or IPPC permits. It is obvious to us (and industry) that different standards, requirements and approaches are used for each. Interest has been expressed by industry in these discrepancies and it is an area where we feel that we could bring value to discussions.

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

We use commercial accredited laboratories.

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

As above.

**Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:**

As above.

## Fisheries and Oceans Canada

Fisheries and Oceans Canada  
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rouleaucl@dfo -mpo.gc.ca

### Second Contact Details:

#### Website:

Phone:  
Fax:

## Radionuclide (and other contaminants) Transfer

*Conduct studies on transfer processes in environment in a multipollution context* No

*Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:* No

*Contaminants: Heavy Metals; PAH's; PCB's; Pesticides; Radionuclides; Other*

### *Details of working with contaminants*

Organometallic compounds

*Ecosystem types: Marine (M)*

*Experiment types: Controlled Environment*

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** No

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** No

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** Yes

### **Organism types:**

Marine: Crustaceans; Fish; Invertebrates; Molluscs

**Contaminants: Heavy Metals; PAH's; PCB's; Pesticides; Radionuclides; Other**

### **Details of working with contaminants**

Organometallic compounds

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

- dedicated wet lab for studies with radiomarkers
- in vivo gamma counting (2 3" NaI detectors)
- counting room (3 Xtra Ge detectors, Wizard gamma counter, TriCarb LSC)
- liquid nitrogen generator
- autoradiography laboratory (CM3600 cryomicrotome for large specimens, Cyclone PhosphorImager system)
- radiochemistry laboratory (HPLC -FSA, glove box for synthesis)
- 4 400 -L, 10 70 -L, 12 30 -L tanks
- 6 3000 -L mesocosms (2006)

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

- AAS
- ICP -MS
- GC -MS
- gamma spectrometry
- LSC

## Friedrich -Schiller -Universität

Friedrich -Schiller -Universität  
Inst. Microbiology  
Neugasse 25  
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### First Contact Details:

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erika.kothe@uni -jena.de

### Second Contact Details:

**Website:** <http://penguin.biologie.uni-jena.de/phytopathologie/mikrobPhytopatho/home.html>

Phone:  
Fax:

## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context**

Yes

### Details of experience and strengths on transfer processes:

Studies on ectomycorrhizal fungi: regulation of genes in mycorrhiza, phosphate transporters, heavy metal resistance, morphotypes on contaminated field sites (Königsberg, Wismut, Germany), isolation of fungi, ITS sequence phylogenetics, in vitro synthesis of mycorrhiza, transfer of heavy metals (Cr, Cd, Ni, U, Sr)

Studies on heavy metal resistance in streptomycetes: isolation of strains from contaminated field sites (Wismut, Germany and Bad Liebenstein, Germany), Ni adsorption, retention, uptake, intracellular sequestration mechanisms, efflux transporters, superoxide dismutase, melanin induction, Cd retention from soil water, cellular response to Cd or Ni, 2D gel electrophoresis and Esi-MS for proteomics, Siderophores and Chelates

Development of CHIP for environmental detection of bacteria, functional Chip for basidiomycete resistance genes

Pot experiments, small lysimeters and field investigations for VAM and uptake into plants (mainly rye and lupine on acidic, sunflower and maize on alkaline substrates)(U, Sr, Th, REE, Ni, Cd, Cr, nutrient elements)

**Ecosystem types: Terrestrial (T)**

**Experiment types: Controlled Environment;** Field

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:**

Yes

### Details of experience and strengths on multipollution effects:

Availability of RI and HM in pore water, sequential extraction for identify binding state of RI/HM/REE with respect to inoculation: VAM, streptomycetes, basidiomycetes including white rot fungus Schizophyllum commune

**Contaminants: Heavy Metals; Radionuclides**

### Details of working with contaminants

The sites are:

Ronneburg mining district of Wismut, former uranium mine in Eastern Thuringia, closed 1990 and remediated by the Wismut GmbH, sold back to the community of Kauern

We established a field site on a former leaching mine site with acid mine drainage to study the possibilities of phytoremediation and phytostabilization

A site to study natural attenuation is located in the catchment area, within 1 km distance at the Gessen creek downstream from the field site with 40 years of adaptation

A site with specific Cd contamination is located within the bath Bad Liebenstein, Thuringian Forest, where a company has produced fluorescent bulbs during GDR times and contaminations of up to 3000 ppm Cd are found in a catchment area which is subject to yearly floodings.

A third site under investigation is a former phosphate fertilizer plant, Dorndorf -Steudnitz, Dornburg, near Jena where aerosol transport has led to high phosphate, sodium and cadmium (possibly also U) contamination in a gradient with respect to distance from the former plant. The site is a steep hillside with recovering, shrubby grass cover

**Ecosystem types: Terrestrial (T)**

**Experiment types: Controlled Environment; Field**

## **Radionuclide (and other contaminants) Effects**

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

**Experience and strengths in studies on radiation transfer on organisms:**

Uptake into cells (streptomycetes, actinomyces, actinomycorrhizal fungi): intracellular storage compounds, effect of phosphorus, transporters cellular response

Pot experiments with acidic substrate (rye, lupine, VAM, streptomycete inoculation), alkaline substrate (sunflower, maize, VAM), neutral soil (sunflower, rye, streptomycete strains for retention from soil water, VAM, nodulation on clover)

Field experiments (Wismut: rye, sunflower, effect of soil amendments of topsoil and compost, effect of inoculation, water regime; ectomycorrhiza and effect on uptake of HM, nutrients and RI)

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** Yes

**Experience and strengths on multipollution effects:**

especially phosphate fertilization effects, using different uptake systems in the fungi for phosphorus depending on soil pH

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:**

**Organism types:**

Terrestrial: Bacteria

Fungi, VAM, basidiomycetes: (T)

**Contaminants: Heavy Metals; Radionuclides**

**Details of working with contaminants**

REE, Ni, Cd, Cr, Zn, Fe, Mn, Mg, Cu, Hg, Pb U, Th, Sm P, N, K

**Biological effects studied with respect to the effect of multipollutants on biota:**

Transcriptome, proteome, superoxide dismutase, aldehyde dehydrogenase, specific gene regulation

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** No

**Details:**  
not yet

## **Facilities**

***Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:***

ICP -MS, AAS, ICP -OES, TEM. No valence states

***Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:***

s.a.

***Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:***

full molecular biology and genetics, simple physiology and full microbiology

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## IRSN

IRSN  
Laboratory of Radioecology &  
Ecotoxicology  
CE Cadarache, Blg 186  
St PaulLez Durance  
France  
13115

### First Contact Details:

Christelle Adam

Phone:

Fax:

### Second Contact Details:

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Phone:

Fax:

## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

### **Details of experience and strengths on transfer processes:**

Joint exposure and/or effect of radionuclides and non radioactive metals. (search for synergism or antagonism). Use of biomarkers of effect.

Studied biological models : algae (*Chlamydomonas reinhardtii*), invertebrates (daphnids) and fish (*Danio rerio*, rainbow trout)

**Ecosystem types: Freshwater (F)**

**Experiment types: Controlled Environment**

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** No

**Contaminants: Heavy Metals; PAH's; PCB's; Pesticides; Radionuclides**

### **Details of working with contaminants**

Only past studies dealt with organic micropollutants & radionuclides. Present research is focused on non radioactive metals & radionuclides

**Ecosystem types: Freshwater (F)**

**Experiment types: Controlled Environment**

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

**Experience and strengths in studies on radiation transfer on organisms:**

Completed in the previous form

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** Yes

**Experience and strengths on multipollution effects:**

Completed in the previous form

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:**

**Organism types:**

Freshwater: Crustaceans; Fish; Molluscs; Plants

**Contaminants: Heavy Metals; Pesticides**

**Details of working with contaminants**

Uranium, isotopes of Cs and Co, Am-241 Cd, Zn, Se

**Biological effects studied with respect to the effect of multipollutants on biota:**

Effects on reproduction (daphnids) and growth (algae)

Biomarkers of oxidizing stress, genotoxicity & energy allocation

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** No

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

Laboratory controlled conditions for aquatic & terrestrial ecosystem study

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

Radionuclide (alpha - Quantulus) and gamma (Germanium probe) ) and metal (ICP-OES) measurements

**Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:**

Comet assay (alkaline conditions)

Enzymatic activity (SOD, GPx, GSH; GSSG, CAT)

## iThemba Laboratory for Accelerator Based Sciences

iThemba Laboratory for Accelerator Based Sciences  
Environmental Radioactivity Laboratory (Physics Group)  
P.O. Box 722  
Somerset West  
7129  
South Africa

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### Second Contact Details:

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Fax: +27 21 8433525  
jps@tlabs.ac.za

## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context**

Yes

### Details of experience and strengths on transfer processes:

Looking at transfer of Na-22 and Zn-65 from soil to ecosystems.

**Ecosystem types:** Terrestrial (T); Freshwater (F)

**Experiment types:** Field

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:**

No

**Contaminants:** Heavy Metals; Pesticides, Commercial radioisotopes

**Ecosystem types:** Terrestrial (T); Freshwater (F)

**Experiment types:** Field

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

**Experience and strengths in studies on radiation transfer on organisms:**

Measurement of activity concentrations in soil/water/vegetation using gamma -ray spectroscopy.

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** No

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** Yes

**Experience and strengths on capability to conduct studies:**

We have PIXE capabilities here at our laboratory.

**Organism types:**

Terrestrial: Birds, Plants

Freshwater: Fish

**Contaminants:** Heavy Metals; Pesticides

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

Shielded HPGe. Mobile scintillator detector, PIXE, Liquid Scintillation Counter, not accredited

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

We have a basic chemistry lab on site (not accredited).

**Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:**

Capability exists to study radiation damage at cellular level using staining and microscope (e.g. looking at micronuclei).

## McMaster University

McMaster University  
Medical Physics & Applied Radiation Sciences  
1280, Main St. West  
Hamilton  
Ontario  
Canada  
L8S 4K1

### First Contact Details:

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Professor (Canada Research Chair)  
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**Website:** www.McMaster.Ca

### Second Contact Details:

Colin Seymour  
Professor (Industrial Research Chair)  
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SEYMOUR@McMaster.Ca

## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** No

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

### Experience and strengths in studies on radiation transfer on organisms:

In vitro and in vivo exposures of fish to heavy metals and radiation

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** Yes

### Organism types:

Terrestrial: Mammals

Freshwater: Fish

**Contaminants: Heavy Metals; Pesticides**

### Details of working with contaminants

Cd, Ni, Cu, prochloraz, neuyphenol, dichloroaniline

### Biological effects studied with respect to the effect of multipollutants on biota:

Bystander effects, delayed low dose effects (death apoptosis), gene and protein upregulation

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

### Details:

Would be interested

## **Facilities**

***Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:***

Fish (freshwater) experiments are of interest especially exposures in a background of chronic heavy metal exposure

***Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:***

to follow

## Norwegian University of Life Sciences

Norwegian University of Life  
Sciences  
Department of Plant and  
Environmental Sciences  
P.O. Box 5003  
Ås  
Norway  
N-1432

### First Contact Details:

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### Second Contact Details:

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ole-christian.lind@umb.no

## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

**Ecosystem types:** Terrestrial (T); Marine (M); Freshwater (F)

**Experiment types:** **Controlled Environment;** Field

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:**

**Contaminants:** **Heavy Metals; PCB's; Pesticides**

**Ecosystem types:** Terrestrial (T); Marine (M); Freshwater (F)

**Experiment types:** **Controlled Environment;** Field

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** Yes

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** Yes

### Organism types:

*Terrestrial:* Bacteria, Crustaceans, Insects, Invertebrates, Mammals, Plants, Soil Fauna

*Marine:* Bacteria, Crustaceans, Fish, Insects, Invertebrates, Mammals, Plants

*Freshwater:* Bacteria, Crustaceans, Fish, Insects, Invertebrates, Mammals, Plants

**Contaminants:** **Heavy Metals; Radionuclides**

## **Facilities**

***Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:***

Analyse gamma, beta and alfa. Does isotope analysis with ICP-MS. Speciation of radionuclides and elements Gamma radiation facility.

***Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:***

Analyse gamma, beta and alfa. Does isotope analysis with ICP-MS. Speciation of radionuclides and elements Gamma radiation facility.

***Describe your organisation's facilities with respect to analysis of biological effects providing details of any analysis performed:***

Just started to analyse early effects - from free radikal induction

## Riso National Laboratory

Riso National Laboratory  
Radiation Research  
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4000

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Head of Programme  
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**Website:** <http://www.risoe.dk>

**Second Contact Details:**  
Per Roos  
Senior scientist  
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Fax: +45 4677 5330  
per.roos@risoe.dk

### Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

**Details of experience and strengths on transfer processes:**

Field data collected over many decades on transfer of mainly Sr-90 and Cs-137 through human food chains.

**Ecosystem types:** Terrestrial (T); Marine (M)

**Experiment types:** Field

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** Yes

**Contaminants:** Radionuclides

**Details of working with contaminants**

Cs-137, Sr-90, Tc-99, Pu-isotopes, Am-241, I-129

**Ecosystem types:** Terrestrial (T); Marine (M)

**Experiment types:** Field

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

**Experience and strengths in studies on radiation transfer on organisms:**

Long term monitoring programmes.

**Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):** No

**Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:** No

**Organism types:**

Terrestrial: Mammals, Plants

Marine: Crustaceans, Fish, Invertebrates, Mammals, Molluscs, Plants

Freshwater: Fish, Plants

**Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:** Yes

## Facilities

**Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

Gamma spectrometry, Cs-137, alpha spectrometry, Pu-isotopes, Am-241, Po-210, beta spectrometry, Tc-99, Sr-90, mass spectrometry, Pu-isotopes, Np-237, U-isotopes, Th-isotopes

**Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:**

Well-equipped chemical labs for low-level analyses.

SENES Oak Ridge, Inc., Center for Risk Analysis  
 102 Donner Drive  
 Oak Ridge  
 Tennessee  
 United States  
 37830

**First Contact Details:**  
 Kathleen Thiessen  
 Senior Scientist  
 Phone: 865 483-6111  
 Fax: 865 481-0060  
 kmt@senes.com

**Website:** www.senes.com

**Second Contact Details:**  
 Owen Hoffman  
 President  
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 Fax: 865 481-0060  
 senesor@senes.com

**Radionuclide (and other contaminants) Transfer**

*Conduct studies on transfer processes in environment in a multipollution context* No

*Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:* No

**Radionuclide (and other contaminants) Effects**

*Conduct studies on radionuclide transfer to organisms in a multipollution context:* No

*Conduct studies of the effects of multipollution on biota (e.g.synergistic effects of radioactive and other pollutants:* No

*Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:* No

*Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:* Yes

Details:

Our organization has developed and used methods for screening and assessing a variety of radioactive and non-radioactive contaminants in several types of situations. Several references are listed below.

Reed, E.W., Thiessen, K.M., Hoffman, F.O., and Apostoaei, A.I. 2003. Comparison of doses and risks obtained from dose reconstructions for historical operations of federal facilities that supported the development, production, or testing of nuclear weapons. *Health Physics* 84(6):687-697.

Thiessen, K.M., Hammonds, J.S., Lewis, C.J., Hoffman, F.O., and White, E.I. 1996. Screening Method for the Oak Ridge Dose Reconstruction. A Task 7 Report. ChemRisk, State of Tennessee. April 1996.

Thiessen, K.M., Hoffman, F.O., Hammonds, J.S., and White, E.I. 1995. A Review of the Preliminary Screening Analysis Carried Out during the Oak Ridge Dose Reconstruction Feasibility Study. ChemRisk, State of Tennessee, August, 1995.

Hoffman, F.O., Blaylock, B.G., Frank, M.L., and Thiessen, K.M. 1993. A risk-based screening approach for prioritizing contaminants and exposure pathways at Superfund sites. *Environ. Monitoring and Assessment* 28:221-237.

## SPA "Typhoon"

SPA "Typhoon"  
Sector of Environmental  
Modelling and Risk Analysis  
82 Lenin Ave.,  
Obninsk  
Kaluga region  
RUSSIA  
249038

### First Contact Details:

SAZYKINA

Phone:

Fax:

### Second Contact Details:

#### Website:

Phone:

Fax:

## Radionuclide (and other contaminants) Transfer

*Conduct studies on transfer processes in environment in a multipollution context* No

*Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:* Yes

*Contaminants: Dioxins; Pesticides*

*Ecosystem types:* Terrestrial (T); Marine (M); Freshwater (F)

*Experiment types: Controlled Environment; Field*

## Radionuclide (and other contaminants) Effects

*Conduct studies on radionuclide transfer to organisms in a multipollution context:* No

*Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):* No

*Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:* No

### Organism types:

*Freshwater:* Fish, Mammals, Molluscs

*Contaminants: Dioxins; Pesticides*

*Have performed Environmental Risk Assessments for radioactive and non-radioactive pollutants and/or have interest in it and/or would like to contribute in a comparison of approaches in environmental risk assessment for conventional contaminants and radionuclides:* Yes

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## Università Cattolica del Sacro Cuore

Università Cattolica del Sacro Cuore  
Faculty of Agricultural Sciences  
Institute of Agricultural and Environmental  
Chemistry  
Via Emilia Parmense, 84  
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## Radionuclide (and other contaminants) Transfer

*Conduct studies on transfer processes in environment in a multipollution context* No

*Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:* No

**Contaminants:** Heavy Metals; Radionuclides

**Ecosystem types:** Terrestrial (T)

**Experiment types:** Controlled Environment; Field

## Radionuclide (and other contaminants) Effects

*Conduct studies on radionuclide transfer to organisms in a multipollution context:* No

*Conduct studies of the effects of multipollution on biota (e.g. synergistic effects of radioactive and other pollutants):* No

*Capability to conduct studies of the effect of multipollutants on biota, if you do not already conduct them:* No

## Facilities

***Describe your organisation's radioanalytical facilities providing details of radionuclide isotopes analysed and any accreditation status:***

The Faculty of Agricultural Sciences in Piacenza is equipped with a Radioisotopes Laboratory, a centralized facility where the researchers of the Faculty working with radioisotopes are admitted. The laboratory is equipped with a control of the air outlet, an area for the temporary waste storage, a climatic cell for studies in controlled conditions. Radioisotopes are used: (i) as tracers, by different Institutes, f.i. to study the accumulation and transport of photosynthesis products in plants, to identify strain of bacteria by hybridization of DNA, to study biodiversity in animals, to study the endocrinology in animals employing radioimmunological techniques or to follow the degradation of pesticides in controlled environment; (ii) for radioecological studies, to assess the behaviour of radiopollutants in terrestrial systems in controlled conditions. Analysed radionuclides are: artificial gamma emitters (by a GeHp) as  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{85}\text{Sr}$ ,  $^{65}\text{Zn}$ ,  $^{125}\text{I}$  (by a NaI), beta emitters as  $^{14}\text{C}$ ,  $^{32}\text{P}$ . Radioecological studies are conducted in an experimental field annexed to the university and approved by the local health unit.

***Describe your organisation's chemical analytical facilities providing details of radionuclide isotopes analysed and any accreditation status:***

Inductively coupled plasma optical emission spectrometer ICP-OES. In few months: inductively coupled plasma mass spectrometer ICP-MS

## University of Helsinki

University of Helsinki  
Laboratory of Radiochemistry  
P.O.Box 55  
Helsinki  
Finland  
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**Website:** <http://www.chemistry.helsinki.fi/radlab/>

## Radionuclide (and other contaminants) Transfer

**Conduct studies on transfer processes in environment in a multipollution context** Yes

### Details of experience and strengths on transfer processes:

longterm behavior of weapons tests fallout radionuclides in the environment and in the food chains in the Finnish Lapland- body-burden cesium in the Finnish Sami people- Am, Cm na d Np fallout from the Chernobyl accident in Finland- Pu in the air at the Semipalatinsk nuclear test site ion Kazakhstan- radiological characterization of the Semipalatinsk nuclear test site- heavy metals and radionuclides in Lake Umbozero at the Kola Peninsula, Russia

**Ecosystem types: Terrestrial (T); Freshwater (F)**

**Experiment types:** Field

**Conduct studies of the effects of multipollution on the environmental behaviour (migration/bioavailability) of radionuclides:** Yes

**Contaminants: Heavy Metals; Radionuclides**

**Ecosystem types: Terrestrial (T); Freshwater (F)**

**Experiment types:** Field

## Radionuclide (and other contaminants) Effects

**Conduct studies on radionuclide transfer to organisms in a multipollution context:** Yes

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