

Enhancing Education and Training

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www.star-radioecology.org
www.radioecology-exchange.org

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Objectives

Key Goal : *To meet the demand for both worker training and student education in an integrated and sustainable way.*

1. To strengthen and secure a sustainable integrated European training and education platform in radioecology that will attract top-level graduates,
2. To maintain a relevant workforce that is in a position to meet future economic and societal needs within the nuclear sciences,
3. To enhance the mobility of teachers and STAR scientists as a means of securing competence building.

Objectives

To meet the objectives STAR have consulted and engaged with stakeholders on the present status and the training and education needs within radioecology as an essential part of nuclear sciences.

The objectives were to identify the demands for and supply of relevant training and education in radioecology in Europe, to investigate possible educational structures.

Interaction with stakeholders, 2 Workshops

Demand Workshop

- Regulators/Authorities
- Industry
- International Organisations
- Others (Networks, Consultants)

Supply Workshop

- Academics
- Training networks
- International Organisations
- Others (Industry, e-learning)

What are the current and future drivers for radioecology skills?

- Nuclear Renaissance
- Regulatory changes

What are the demands for Education and Training within Radioecology?

www.star-radioecology.org
www.radioecology-exchange.org

What types of training infrastructures are needed? How to stimulate student interest?

Workshop Sessions – Demand (Oslo)

- Session 1: What are the drivers for radioecology?
- Session 2: What skills are the employers looking for in their workforce?
- Session 3: How to implement training and education?



Workshop Sessions – Supply (Helsinki)

- Session 1: What is radioecology? What education and training courses to offer?
- Session 2: How to do it? Education and Training in the 21st Century
- Session 3: How to do it: Networking, Funding and Sustainability

Attendees

47 stakeholders (non-STAR):

- Regulator/Authority: EA, SEPA, CEA, NRPA, STUK
- Industry: Posiva, SCK, Vattenfall, NNL, Fortum, EiCLIT
- International: CNSC, ENS, Bioprota, US-DoE, NCore, WNA, JRC/Nucleonica, NATO, AECL, IUR
- Educators: Nuclear First, EmPower, McMaster Uni, Liverpool Uni, Madrid Univ, ...
- EU projects: CINCH, DoReMi, EUTRAP, NERIS

Output from stakeholders

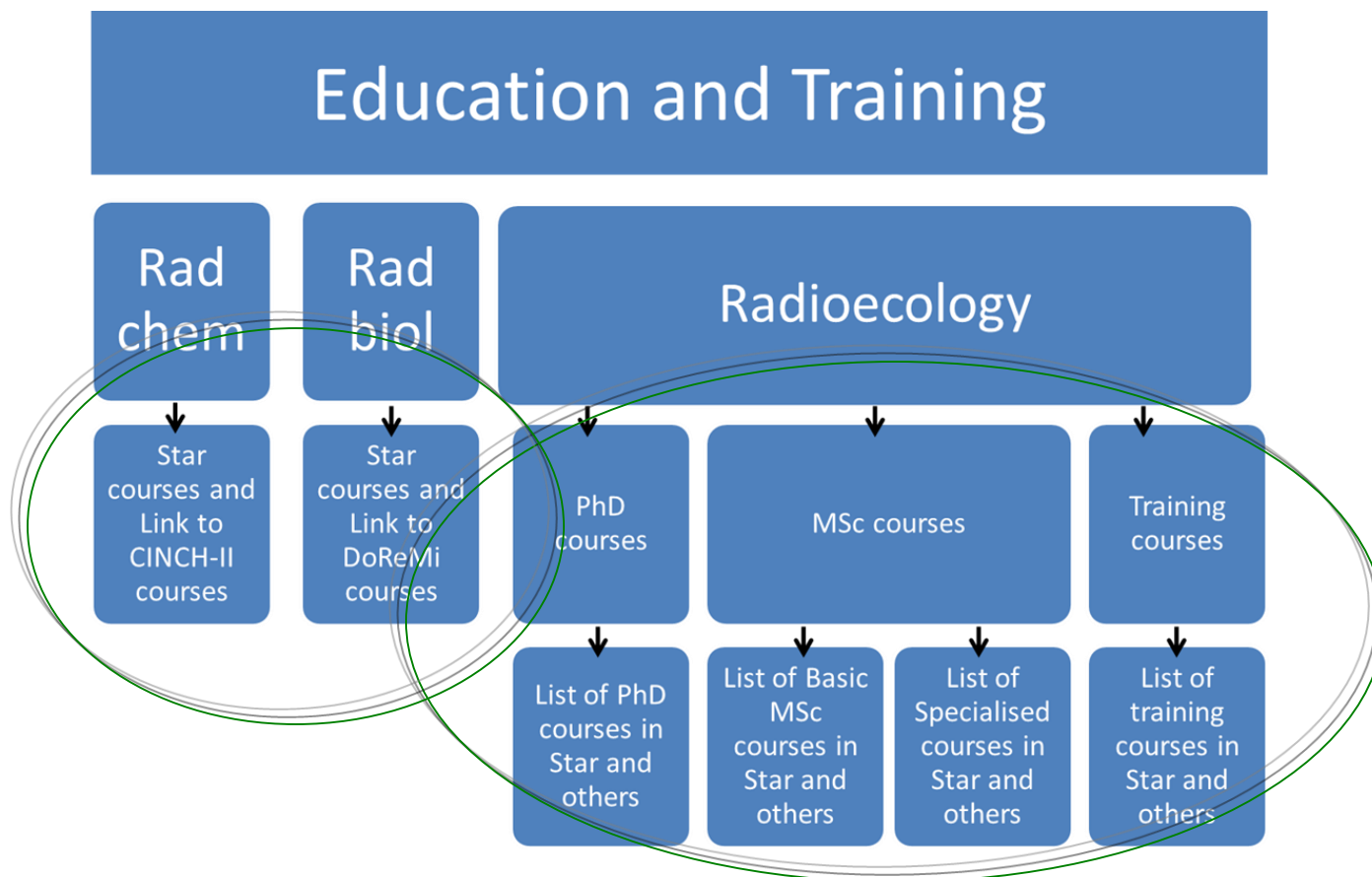
- Both workshops highlighted recruitment as being essential for the future of radioecology.
- It is important to influence young people, even undergraduates and school children, as research has shown that their interest in science should be encouraged at this stage.
- There was a strong awareness of the need to better engage with industry and future employers.
- Concrete suggestions such as offering placements, joint research projects and summer jobs were activities that were proposed at both workshops.
- The multi-disciplinary nature of radioecology was an aspect that could be made attractive to students – there is both demand and a variety of possible job opportunities available to candidates.



Output from stakeholders

- Training in close connection to stakeholders, especially industry, will be important to secure that training is relevant.
- The networking and contacts made as part of these two stakeholder workshops will form a strong foundation to further developments in the STAR education and training activities.
- Both to encourage recruitment, as well as for training and education purposes a series of tools should be applied, including social media (face book, twitter etc), web based tools such as e-learning, distant learning and web pages.
- However, most agreed that analytical and experimental training must be based on hands-on laboratory exercises.
- Finally there are several existing educational and training networks, and STAR needs to foster and strengthen existing links with these.

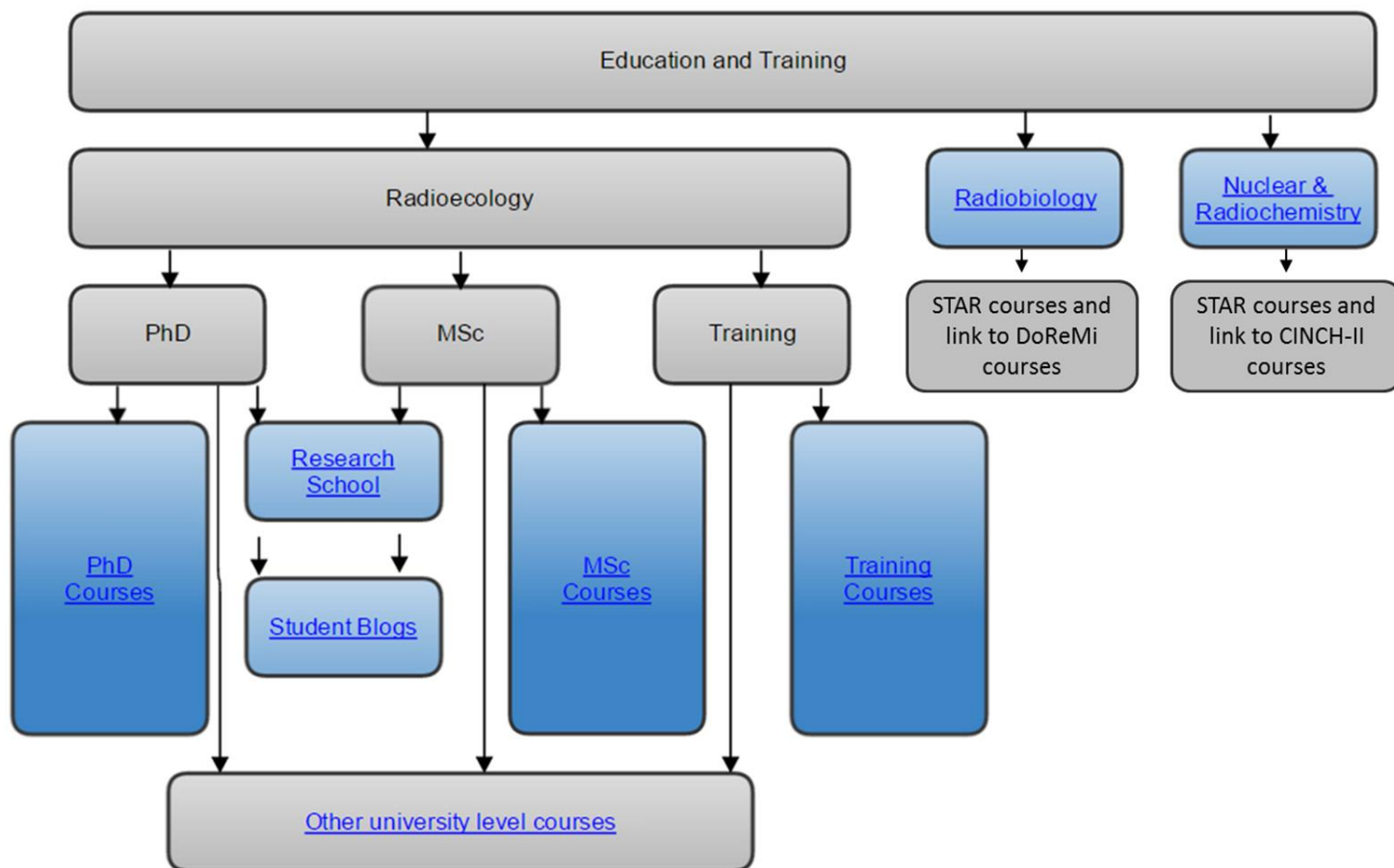
Education and Training platform



Education and Training platform

- The Radioecology Education and Training Platform (E&T platform) is a website focal point for students and professionals interested in radioecology.
- The platform presents an overview of education and training course modules within radioecology/environmental radioactivity presently offered by the STAR and COMET consortium.
- Information on course curriculums and learning outcomes are provided, with recommended pathways to obtained academic merited education (MSc, PhD).
- The Radioecology E&T platform also provides links to other E&T platforms, such as those within Radiochemistry, Radiobiology and Radiation Protection.
- This is an important outreach mechanism for the Radioecology E&T platform, as – for example – many of the basic course modules within radioecology are also relevant for other nuclear science students, and vice versa.

Education and Training platform



PhD research school

- A virtual forum to promote networking and interaction between STAR students and scientists and the rest of the radioecology community.
- Offer joint courses, co-supervision, student exchange, study placements
- Open to all PhD students associated with STAR partners or from other establishments (e.g., through ALLIANCE, IUR, WNU, etc.)
- Ideally, student driven and managed (Social media and networking)
- Launched on Radioecology Exchange – promotion in Canada 2011; Environmental Radiation Conference Plymouth 2012
- 39 past and present members, many joined courses

European master in radioecology

- EU and OECD have identified an urgent need of university trained candidates within nuclear sciences: radiochemistry, radioecology, radiation protection in Europe and world-wide.
- Radioecology is the key research area linking authorized or accidental releases from nuclear sources to impact and risk assessments and to the radiation protection of man and the environment.
- The need for a European MSc in Radioecology and revised syllabus for such programme was presented during EU EURAC project (2005).
- Master programme in Radioecology was established in 2007 at the Norwegian University of Life Sciences (NMBU) according to the Bologna model during EU ENEN-II project.

European Master programme within Radioecology

Norwegian University of Life Sciences (NMBU)

MoU with:
Aix-Marseille
and
Moscow State
University

ERASMUS+
agreements



MINA310 Project Management and Research Methods
10 credits
1 week intensive and autumn parallel

KJM351 Radioecology
5/10 credits
2-3 weeks intensive teaching
delivery of full laboratory report, written assignment and written exam
- Revised under EU STAR

Risk Management and Emergency Planning
Marseille, France,

Current Courses in Radioecology MSc

Radiation protection and waste management
Marseille, France,

KJM350 Radioactivity and Radioanalytical Techniques
10 credits
3 weeks intensive teaching
delivery of a number of full laboratory reports and written exam
- Revised under EU CINCH-II

KJM360 Assessing Risk to Man and the Environment
10 credits
2 weeks intensive teaching
Delivery of risk assessment report and oral exam

Optional: MINA410 Environmental Radiobiology
PhD 1 week intensive course; 5 credits

STAR courses

- 10 Credit MSc course: Radioecology
- 5 Credit PhD course: Environmental Radiobiology
- Professional Training courses:
 - Protection of the Environment (NERC)
 - Deb-tox/MS (IRSN/SCK)
- Additional courses
 - Web-based BLM and MS

The restructuring and development of the courses has benefited from the input of the both the STAR participants and the STAR E&T stakeholders

Interaction with other EU networks

- Radioecology (CINCH)
- Environmental Radiobiology (DoReMi)

Environmental Protection, Lancaster 2014

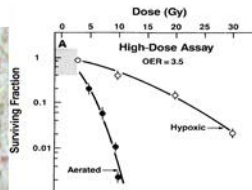
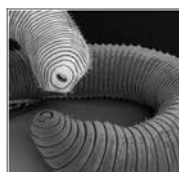


Participants

- One week PhD course on Environmental Radiobiology, held in June 2013 by NMBU, 28 attendees, 9 that took the final exam to get the 5 ECTS.
- Two week MSc course on Experimental Radioecology, held in October 2013 by NMBU, 16 attendees, 13 that took the final exam to get the 10 ECTS. This course was repeated in 2014
- Two week MSc course on Radioecology, held in October 2013 together with Experimental Radioecology, 5 ECTS, at NMBU.
- Three day training course in Mixture Toxicity, held in January 2014 by SCK, 9 attendees.
- Three day training course in Environmental Protection, held in April 2014 by CEH, 18 attendees.

(Two week MSc course on Assessing Risk to Humans and the Environment, held in June 2014 by NMBU. 25 attendees)

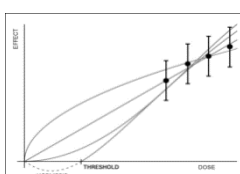
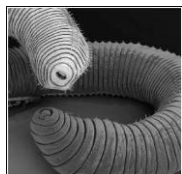
Environmental Radiobiology



Aim: to give students an overview of the fundamental principles of radiobiology, but within the context of effects on non-human biota.

Content: Fundamentals of radiobiology, radiosensitivity; field studies in Chernobyl and Fukushima; laboratory work on biomarker analysis in model organisms.

Assessing Risk to Humans and the Environment



Aim: to give students a grounding in the theory and skills needed to carry out environmental risk assessment for humans and non-human organisms.

Content: theory of risk assessment, epidemiology, radiation protection, ecological risk assessment, ecosystem approach, training in modelling modules including the ERICA assessment tool.

Environmental Radiobiology

28 students; 12 PhD, 8 MSc students, 8 post doc/ professionals; 8 Norwegians, 15 EU and 5 non-EU (USA, Argentina, Russia).



Assessing Risk to Humans and the Environment

25 students: 6 PhD; 12 MSc students, 7 post doc/professionals; 10 Norwegians, 9 EU and 6 non-EU (Brazil, Russia, Turkey).



Student feedback

Environmental Radiobiology

- Overall: Collaboration between DoReMi and STAR/Radioecology
- Good: «The variety of the lectures»; «The group work sessions»; «opportunity to meet other students»
- Bad: «Not enough time for laboratory work»; «wifi trouble in the student accomodation»
- Will be repeated in 2015 (DoReMi and COMET supported)

Assessing Risk to Humans and the Environment

- Good: «Learning how to use ERICA»; «The high quality of the lectures/lecturers»
- Bad: «The price of beer»;
- Good: «The free beer»
- NMBU online student evaluation awarded the course the second highest rating of all MSc courses held by the department this semester
- Plan to repeat in 2016

STAR courses

- The courses aimed not only to fill the identified European postgraduate education gap in radiological sciences, but also to provide a modular structure that is easily accessed by stakeholders for professional development training.
- The courses attracted students from different countries and included PhD students, MSc students as well as professionals
- There was a more than a 100% increase on past attendance for the MSc and PhD courses,
- For some of the courses, exams were arranged at home universities.



«Mobility Stimulus»

- 60 kEuro allocated to "mobility stimulus"; ca. 5 kEuro per partner.
- Intention: Support of long-term exchange visits between partners.
 - Worker and student exchange visits, joint field-work and experiments (~1 weeks)
 - Student supervision
 - *Not* attendance of STAR workshops and meetings
- Examples
 - Worker and student exchange visits
 - Joint field-work and experiments
 - Student supervision

Interaction with other platforms

- Web platform information shared
- Interaction with DoReMi, Neris and CINCH-II
 - Lectures given at DoReMi Radiobiology MSc course on Epidemiology and Radioecology
 - ERASMUS+ and MoU with CINCH-II partners
- Lectures on other Environmental Science courses and Education Programmes



Environmental Radiobiology, 2011

E&T included in the SRA

Intro (revision of existing text):

- *"The SRA prioritises three important **Scientific Challenges** that radioecology needs to address and one **Education and Training Challenge**.*
- *Each of the scientific challenges is developed as a separate section of the SRA. Each includes a **Vision Statement** of what should be accomplished over the next 20 years in that area of radioecology, followed by a **Strategic Research Agenda** of key research lines required to accomplish the vision.*
- *A similar approach is adopted for Education and Training.*
- *Addressing these challenges is important to the future of radioecology and in providing adequate scientific knowledge to decision makers and the public, and a relevant and trained workforce for industry and other stakeholders."*

Future of the STAR E&T platform

- The E&T platform within the SRA should be a valuable tool for the ALLIANCE
- The E&T platform will be maintained and further developed within COMET
 - The STAR E&T course portfolio should be maintained and developed as far as possible within COMET, forming the E&T basis directed to research scientists, stakeholders and students.
 - Although E&T funding in COMET will not cover all courses included in the STAR E&T platform, previous EC investments in E&T in radioecology (EURAC, ENEN-II, STAR) should be utilized if possible.
- The Radioecology E&T platform should be utilized within CONCERT JEP

Conclusions

- Overall, STAR has made an important contribution to the education and recruitment of students to radioecology in Europe, as well as strengthening international recognition of radioecology as a relevant discipline for other areas of nuclear science.
- Recognition of the importance of E&T is within its SRA
- STAR E&T has achieved a high international profile by interacting with other EU E&T networks (DoReMi, CINCH, NERIS, etc) which will be essential for ensuring the integration of STAR and Radioecology in future EU projects and networks and is especially important within the CONCERT JEP.
- Interaction with stakeholders has been very good, including participation of students from a number of institutions both inside and outside of the STAR network.
- Several PhD and MSc students - the "STARs" who will ensure the future success of radioecology

STAR PhD students

- Extensive list can be found at the Radioecology Exchange webpage
- PhD research school
 - PhD students working at STAR institutes
 - PhD students who have completed their projects

<https://wiki.ceb.ac.uk/display/radex/List+of+PhD+students>

- PhD research school will be further developed in COMET

University of Stocholm:

- Dina Abdul Meseh, The impact of gamma irradiation and cadmium on *Daphnia magna* and *Pseudokirchneriella subcapitata* (2012 – 2013)
- Hiba Alasawi, Studying the effects of gamma radiation and cadmium on zooplankton and phytoplankton (2012 – 2013)
- Elinor Eriksson, Developing methods to assess dose response relationships in blue mussel (*Mytilus edulis*) cells exposed to radiation and PAHs. (2012)
- Eric Wassén, Single toxicity versus mixture toxicity testing – a focus on fluoranthene, cadmium and γ -irradiation. (2014)
- Nicklas Östenius, A critical review of interactive effects of chemical mixtures: can we safely disregard synergism and antagonism? (2012)
- Elina Viinamäki - research internship, 2015.

IRSN:

- Tristan Lecomte (2014). Development of a BLM model to predict the acute toxicity of uranium to daphnids. Impact of cadmium on this toxicity. MSc INSA de Lyon – ENTPE. (report in French)
- Cécile Dubois (2014). Study of the effects of a binary mixture of uranium and fluoranthene on nematodes *Caenorhabditis elegans*. Montpellier University (report in French)
- Loic Minko mi Ondo (2013). Development of a model describing the bioavailability of uranium to daphnids. Aix-Marseille University (report in French)

Norwegian University of Life Sciences:

- Lene Valle, Concentration and uptake of NORM in berries and mushrooms in a thorium rich area and possible doses to the population (2011-2012)
- Yevgenia Tomkiv, Ecological risk assessment for a former radium production site in Komi Republic, Russia (2011-2012)
- Stefanie hernandez Sanches, Potential Mobility of Radionuclides and Trace Elements in Bedrock Materials and in the Deposition Area at a Tunnel Construction Site (2013-2014)
- Tari Helmers, The mobility of uranium from U-containing bedrock materials as a function of pH: Implications for tunnel construction (2012-2013)
- Emanuel Lapied, Impact of gamma irradiation on apoptotic activity in the earthworm *Eisenia fetida* (Clitellata) (2013-2014)
- Thapelo Nthokana, Migration of heavy metals and radionuclides in terrestrial ecosystem, Serule case study (2013-2014)
- Nina Bratteteig, Pu isotope ratios in contaminated sediments – source identification of releases from nuclear reprocessing plants (2014-2015)
- Maren Hjulstad, Leaching, uptake and effect in Brown Trout (*Salmo trutta*) of radionuclides and metals from black chales and sulphur bearing gneiss (2014-2015)

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