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Strategic Plan for Securing Long Term Sustainability for Education and Training in Radioecology

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STAR

STRATEGY FOR ALLIED RADIOECOLOGY

EURATOM

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Executive Summary

Studies undertaken in the last decade by European and international organizations, have shown that regarding the nuclear sciences (including radioecology) there is a decreased student interest, decreased course numbers and ageing faculty members and facilities.

Taking this situation into account, the Mobility, Training and Education Work Package (WP6) of the STAR Network of Excellence (NoE) had three main objectives: 1) to strength and secure a sustainable integrated European education and training 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, and 3) to enhance the mobility of teachers and STAR scientists as a means to secure a goal of competence building.

Within the STAR NoE, a Radioecology Education and Training Platform (E&T platform) has been developed to be a website focal point for students and professionals interested in radioecology. A sustainable integrated European E&T platform in radioecology is needed to preserve and increase the knowledge gained during the last few decades, allowing the maintenance of a relevant workforce that is in a position to meet future economic and societal needs within nuclear and environmental sciences, and will also help to attract top-level graduates, needed for the future of radioecology.

In this deliverable (D6.4) the E&T platform in radioecology developed by STAR is presented (Section 2). The E&T platform is part of "The Radioecology Exchange", a web resource that is intended to become a 'gateway' for information related to European (and wider) radioecological research. Section 2 also describes the importance of forums, such as websites, conferences, meetings, social media, to stimulate students and facilitate their interaction with experts. Within STAR several forums have been created, including:

- PhD Research School, a virtual forum created to promote networking and interaction between STAR students;
- Workshops and courses (see section 3), where students have had the opportunity to interact with experts, as well as to express their concerns, opinions and needs.
- Social media. STAR has provided both a Twitter account and a Facebook page on Radioecology and Environmental Radioactivity, where people interested in following science news or information on courses and education within radioecology, can get information and even interact.

In section 3 an evaluation of the education and training programme in radioecology is presented, including the MSc programme in Radioecology and the four E&T courses organized by STAR (MSc course in Experimental Radioecology; PhD course in Environmental Radiobiology; STAR Mixture Toxicity, DEB and Risk Assessment Workshop; and Radiological Protection of the Environment - a professional development training course).

The mobility strategy for profitable use of expertise, resources, facilities and infrastructures is described in section 4. The section includes a description of the mobility funding opportunities within the European Union (Marie Skłodowska-Curie actions

(MSCA) and ERASMUS+ Key Action 2) and the description of the mobility actions and collaborations that have taken place during the STAR NoE.

A key point to secure the sustainability of the E&T platform in radioecology is the availability of funds. Thus, Section 5 includes the available funding mechanisms to support education, training and mobility within radioecology, at the national and European level, as well as in several radiation protection platforms and organizations.

The strategic plan for a sustainable integrated E&T platform in radioecology is presented in Section 6. The Strategic Research Agenda for E&T in radioecology is summarised in this Section, describing both the strategic vision for E&T in radioecology and the action lines needed to be address to achieve that strategic vision.

Finally, in section 7 of the deliverable, recommendations for the sustainability of radioecology are given. For the future of radioecology, two important needs have been identified: the recruitment of students and young scientists and to better engage with industry, future employers and stakeholders.

Radioecology should be promoted through a variety of courses at the BSc level, for PhD and for professionals. To attract students and young scientists it is also important to further develop and use the social media, e-learning possibilities, virtual laboratories etc. to reach teenagers and young students. The STAR NoE has done a big job creating the Radioecology Exchange, a web portal that contains a lot of useful resources for those interested in radioecology, as the E&T platform (including the PhD Research School) and the virtual laboratory, just to mention some.

As to the future of both the E&T platform and other resources developed during STAR, the main challenge is to get sustainable funding that would allow the maintenance and update of these resources after STAR NoE ends.

The countries/organizations engaged in the E&T platform could contribute: providing students, teachers, work placements, research projects, collaboration on courses or course modules, educational material and logistical support for student exchange

The European project COMET, and for the long-term the European Radioecology Alliance (ALLIANCE) would have to play a key role in the sustainability of the resources developed in STAR. There is also important to further develop and strengthen the links with other radiation protection platforms in Europe (EURADOS, MELODI and NERIS), within the Horizon2020 framework, specifically under the European Joint Programme CONCERT.

List of Acronyms

ALLIANCE	European Radioecology Alliance
BSc	Bachelor of Science
CIEMAT	Centro de Investigaciones Energéticas Medio Ambientales y Tecnológicas (Spain)
CINCH	Cooperation in Education and Training in Nuclear Chemistry
COGER	Co-ordinating Group on Environmental Radioactivity (UK)
COMET	COordination and iMplementation of a pan-Europe instrumenT for radioecology
DoReMi	Low Dose Research towards Multidisciplinary Integration
EACEA	Education, Audiovisual and Culture Executive Agency (EC)
ECTS	European Credit Transfer and Accumulation System
ECVET	European Credit system for Vocational Education & Training
EFTS	Euratom Fission Training Schemes
EMJMD	Erasmus Mundus Joint Master Degree
ENEN-II,-III	Consolidation of European Nuclear Education, Training and Knowledge Management
ENETRAP-II	European Network on Education and Training in RAdiological Protection
EURAC	Securing European Radiological Protection and Radioecology Competence to meet the Future Needs of Stakeholders
EURAYS	European Radiation Research Association for Young Scientists
EURADOS	European Radiation Dosimetry Group
EUTERP	European Training and Education in Radiation Protection Platform
FWO	Fund for Scientific Research - Flanders
FNRS	Fund for Scientific Research - Wallonia
HEI	Higher Education Institutions
HERCA	Heads of the European Radiological Protection Competent Authorities
IAEA	International Atomic Energy Agency
IF	Individual fellowships
IRSN	Institut de Radioprotection at de Sureté Nucléaire (France)
ITN	Innovative Training Networks
IUR	International Union of Radioecology
IWT	Agency for Innovation through Science and Technology

KA	Key Action
MELODI	Multidisciplinary European Low Dose Initiative
MSc	Master in Science
MSCA	Marie Skłodowska-Curie actions
NERC-CEH	Natural Environment Research Council-Centre for Ecology & Hydrology (UK)
NERIS	European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery
NMBU	Norwegian University of Life Sciences
NoE	Network of Excellence
NRPA	Norwegian Radiation Protection Authority
PETRUS-II	Programme for Education, Training and Research on Underground Storage
RI	Research Institute
RII	Research Institutes and Infrastructures
RISE	Research and Innovation Staff Exchanges
RIVM	Rijksinstituut voor Volksgezondheid en Milieu (National Institute for Public Health and the Environment, Netherlands)
RPE	Radiation Protection Expert
RPO	Radiation Protection Officer
SCK•CEN	Belgian Nuclear Research Centre
SETAC	Society of Environmental Toxicology and Chemistry
SFR	Svensk förening för radiobiologi (Swedish Society for Radiation Biology
SFREK	Svensk förening för radioekologi (Swedish Society for Radioecology)
SKB	Svensk Kärnbränslehantering AB,Swedish Nuclear Fuel and Waste Management Co
SSM	Strålsäkerhetsmyndigheten, Swedish Radiation Safety Authority
STAR	STrategy for Allied Radioecology
SWE-RAYS	Swedish Radiation Research Association for young Scientists
VET	Vocational Education and Training

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1 Objectives and Scope

The overarching objectives of the STAR WP6 are to: 1) strengthen and secure a sustainable integrated European education and training platform in radioecology that will attract top-level graduates, 2) maintain a relevant workforce that is in a position to meet future economic and societal needs within the nuclear sciences, and 3) enhance the mobility of teachers and STAR scientists as a means to secure a goal of competence building.

To meet the objectives the STAR NoE has or will:

- consult and engage with stakeholders on the present status and the education and training needs within radioecology as an essential part of nuclear sciences;
- consolidate a sustainable, integrated, education and training platform in radioecology directed to students, research scientists and stakeholders;
- explore mechanisms to stimulate interest in education and training in radioecology;
- implement and test a selection of course modules within radioecology, revise syllabus on exiting courses and utilizing the mobility of expert teachers and as well as of students and trainees; and
- secure funding mechanisms for scientists and students mobility and long-term sustainability of the education and training platform in radioecology.

The objective of Task 6.4 of WP6 is to secure the sustainability of the education and training platform over time. To do so, the following actions were proposed:

- Subtask 6.4.1. In collaboration with the European Radioecology Alliance (ALLIANCE) and stakeholders, develop a strategic plan for a sustainable integrated education and training platform after the termination of the NoE.
- Subtask 6.4.2. Develop a mobility strategy to maximize a profitable use of resources, facilities, infrastructure and expertise within the NoE participants, promoting exchange of scientists and students between partners, provide internships and work experience placements, and include scientists and students in joint experiments, courses and field studies. Promote forums (meetings and websites) where PhD and post-graduate students can disseminate the knowledge resulting from their research and interact with professionals (in collaboration with STAR WP-7).
- Subtask 6.4.3. Investigate sustainable funding mechanisms, including commitments from the NoE participating countries, to support sustainability of the education and training platform through the provision of course sponsorship and studentships.
- Subtask 6.4.4. Evaluation of the topics included in the integrated education and training platform. At the end of the NoE period, provide a full critical evaluation of the performance of the education and training programme in radioecology, and make recommendations for the future.

2. The Education and Training Platform in Radioecology

The ultimate goal of STAR's educational components is to meet the demand for both worker training and student education in an integrated and sustainable way. Such needs are particularly acute in the field of radioecology, as it has been recognized that formal education and training are fragmented, often inadequate, and that mobility is an essential means to support competence sharing (FUTURAE, 2008).

A sustainable integrated European education and training (E&T) platform in radioecology will preserve and increase the knowledge gained during the last few decades, allowing the maintenance of a relevant workforce that is in a position to meet future economic and societal needs within nuclear and environmental sciences, and will also help to attract top-level graduates, needed for the future of radioecology.

The recent renaissance of interest in nuclear power, the Fukushima accident, the application of nuclear techniques in research and industry, the release of radionuclides from hospitals and other non-nuclear industries and the scientific challenges related to the whole nuclear fuel cycle, from mining to waste management, all require increased radioecological competence and support from further research.

An engaging programme for long-term education and training within the nuclear and environmental sciences is required not only in order to have a sustainable nuclear energy programme, but also for the assessment of possible impacts of any anthropogenic or naturally-occurring sources of ionising radiation. Expertise in radioecology is needed by industry as well as authorities and regulators.

2.1. Background information on education and training in radioecology in Europe.

Already in 2000, the OECD/NEA report "Nuclear Education and Training: Cause for Concern?" showed that too few scientists were trained to meet the needs of current and future nuclear industries (OECD-NEA, 2000). Several studies undertaken by European governments have confirmed that there is a decreased student interest, decreased course numbers and ageing faculty members and facilities. Consequently, the European educational skill base has become fragmented. Of particular concern are special skill-based deficits within nuclear radiological protection, radioecology and radiochemistry at masters and doctorate levels. Skills in these areas are of strategic importance for the maintenance of nuclear operations and options within the evolving EU economy. They are also important for meeting the challenges presented by unpredicted events such as the Windscale fire, the Fukushima accident, or terrorist and sabotage activities.

Subsequently, the European project "Securing European Radiological Protection and Radioecology Competence to meet the Future Needs of Stakeholders" (EURAC, 2003), was funded under the 6 Framework of the EU, for two years (2004-2006). The main objective of the project was to strengthen the scientific academic competence and analytical skills within radiological protection, radioecology and radiochemistry and to secure the future recruitment of appropriately skilled postgraduates to meet the needs of European stakeholders (Abbott et al., 2005; Mitchell et al., 2005; Priest et al., 2005; Salbu and Skipperud, 2005; Tamponnet et al., 2005). EURAC focused specifically on education

at the Masters and PhD levels. The surveys showed that despite only 4 MSc level courses being available in radioecology, compared to 17 in radiation protection, the discipline was as widely sought after by government and research employers. This clearly indicated the importance of finding mechanisms to support mobility of students and staff to ensure the success of such European-wide courses. EURAC was followed by the ENEN-II project which supported the initiation of the European MSc in Radioecology at the Norwegian University of Life Sciences (NMBU) (Oslo, Norway) (ENEN-II, 2006).

In the context of the European Union, in December 2008 the Council called for the public and private sectors to take urgent actions to 'reinforce the teaching of basic scientific prerequisites in preparation for energy-related occupations'. The Council also insisted that 'the appropriate conditions must be created for the mutual recognition of nuclear professional qualifications throughout the EU'.

The Council of the EU adopted a directive in June 2009 stressing the importance of education and training in maintaining nuclear safety standards. Specifically, they called on Member States to ensure that their national programmes have requirements for the education and training of all staff with responsibilities relating to nuclear installations. The directive represents a significant step forward in promoting a strong safety culture in Europe.

The supply of qualified personnel is a concern also shared by international organizations (such as the OECD-NEA and the IAEA) and countries collaborating with Euratom (Canada, China, Japan, Russia, South Korea, South Africa and the USA, among others).

Euratom has two major objectives in education and training in all sectors of nuclear fission and radiation protection:

- To establish a single mutual-recognition system across the EU, using the European Credit Transfer and Accumulation System (ECTS).

- To facilitate the mobility of teachers and students, in particular through support from public-private partnerships. Such mobility is essential for a healthy research community, as it allows for cross-pollination of ideas between both cultures and disciplines. Mobility is encouraged for scientists through grants and fellowships that help them move between universities and research institutes within and outside the EU.

Euratom stresses the need of involving future employers in the education process, to help research institutes and universities to optimise the value of their programmes and to better prepare their students for the challenges ahead.

A mechanism of E&T within Euratom are the Fission Training Schemes (EFTS). They are designed to structure research training in all areas of nuclear fission and radiation protection, in order to establish a common certificate for professionals throughout the EU. The EFTS are dedicated to structuring both research training and researcher career development across the EU, and they are not a simple training and mobility programme. The schemes address lifelong learning and career development of experienced researchers, both in the public and private sectors. They target nuclear researchers and

industrial experts at the postgraduate level, from doctoral students to senior visiting scientists.

One of the major objectives of the EFTS is to facilitate the transfer of higher-level knowledge and technology between disciplines, sectors and countries. The ultimate goal is to develop a European passport for Continuous Professional Development, which relies on the principles of common qualification criteria, a common mutual recognition system, and the facilitation of teacher, student and worker mobility across the EU.

Some of the EFTS underway are: ENEN-III on nuclear engineering, ENETRAP-II on radiation protection, and PETRUS-II on radioactive waste disposal.

In 2012, the OECD-NEA published the report *Nuclear Education and Training: From Concern to Capability*, which reviews the initiatives undertaken during the last decade by governments, educational and research institutes, and industry. Such initiatives arise, in many cases, as a consequence of the measures proposed in the 2000 OECD-NEA report, previously mentioned in this deliverable. Although the initiatives undertaken illustrate examples of good practices in a number of countries, concerns remain that sustainable sources of skilled workers have not been established in all areas or in all countries (OECD-NEA, 2012).

As part of the study done for the 2012 report, a survey was conducted on the use of research facilities and laboratories in NEA member countries for education and training. The results show that, in general, existing infrastructure is underutilised for hands-on education and training, and expensive, unique facilities have been shut down or are due to close over the next few years. Regarding the progress in E&T, the report concludes that since 2000, the general outlook of the nuclear energy industry has changed and many initiatives have been launched to increase the E&T capacity. However the challenge still remains, because although in some countries the interest of the students in nuclear sciences has increased, in other countries the trend among young people is to leave technical and scientific disciplines. A remarkable development has been the internationalisation of the nuclear workforce and the associated education and training. This trend puts more emphasis on the need for greater consistency in education and training delivery and course content (OECD-NEA, 2012).

The European EURAC project and the Radioecology Master Programme at NMBU have been important steps in promoting environmental radioactivity as an academic discipline under the Bologna Model (Skipperud et al., 2011). This work has continued in STAR NoE, with increased participation of STAR scientists as teachers, international students and professionals taking course modules, an increase in the number of radioecology graduates as well as interaction and joint courses with DoReMi (low-dose research) and CINCH (radiochemistry).

The STAR NoE has also solicited stakeholder engagement in the development of a strategic agenda through supply and demand of workshops linked to education and training. Thus, within STAR, two workshops were organised in 2011 to discuss, with a variety of stakeholders, the demand and supply for radioecology skills in its workforce today and in the future and give insight into the recruitment needs within radioecology (STAR Deliverable 6.1). The participants in the 1st workshop were those who ultimately employ candidates, while in the 2nd workshop were those who are engaged in education

and training in the nuclear sciences.

Some of the main conclusions of these STAR workshops were:

- Terminology is important. The use of the word "Radioecology" may be confusing to students. Several definitions of radioecology can be made, but common to all is that radioecology covers the environmental behaviour and effects of radionuclides, and that this was a multidisciplinary area. For the purposes of attracting students, there was consensus that environmental radioactivity would be more accessible and understandable to a wider audience than radioecology. But for describing the science and research, radioecology, or radioecology and environmental radioactivity, was preferred.

- Recruitment of students and young scientists is essential for the future of radioecology; it is important to influence young people, even undergraduates and school children. Both to encourage recruitment, as well as for E&T purposes, a series of methods should be applied, including social media (Facebook, Twitter etc.), web-based tools such as e-learning, distant learning and web pages. However, experimental training must be based on hands-on laboratory exercises. The multi-disciplinary nature of radioecology is an aspect that could be made attractive to students. Radioecology should be promoted through a variety of courses at the BSc level – for example as lectures on other environmental science or nuclear science courses.

- There is a need to better engage with industry and future employers. The activities that were proposed at both workshops include: offering placements, joint research projects and summer jobs.

2.2.The STAR Radioecology Education and Training Platform

Within the STAR NoE, a Radioecology Education and Training Platform (E&T platform) has been developed. The Platform is a website focal point for students and professionals interested in radioecology E&T (http://goo.gl/HHcBeA). The platform presents an overview of E&T course modules on radioecology/ environmental radioactivity presently offered by the STAR consortium. Information on MSc and PhD course curriculums and learning outcomes are provided. 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 (Figure 1).

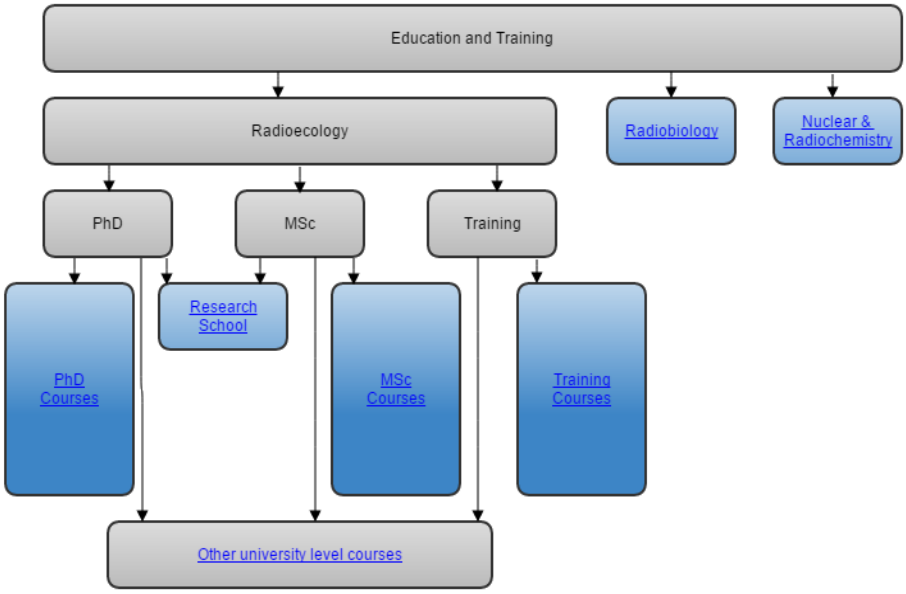

Figure 1: STAR Education and Training Platform (www.radioecology-exchange.org).

An important aspect of this platform is the future maintenance and updating of its information. It should not be a static webpage but provide on-going and new courses, project work, new opportunities etc. and give updated links to information at all times. Such maintenance is a continuous and time consuming work, and after the end of the STAR project, COMET and ALLIANCE will take responsibility for doing this.

Within the E&T Platform, STAR has created the **PhD Research School**, which is a virtual forum created to promote networking and interaction between STAR students. It was formally launched on the 5th September 2012 at a special session of the International Symposium on Environmental Radioactivity, Plymouth University.

The Research School is intended for any PhD student engaged in radioecology research, or related disciplines (radiobiology, ecotoxicology, environmental chemistry, nuclear engineering, radiation protection, among others). To join the research school, the students do not need to be members of STAR or the EU. The students joining the PhD Research School will have priority for places on STAR organized student and training courses. For now it is a virtual forum created to promote networking and interaction between STAR PhD students. Ideally it will facilitate that students are driven and managed, through social media and networking.

The Research School currently has 18 PhD students participants associated to 6 of the STAR partners and 3 students that are not directly connected to STAR. Seventeen others have now obtained their PhDs

To secure the sustainability of the E&T platform in radioecology developed in STAR (including the PhD Research School), the platform will be further developed under the COMET project and will be long-term supported by the ALLIANCE.

2.3.Forums for students

It is crucial that PhD and post-graduate students can interact with professionals to discuss the results of their research activities, and also to disseminate these results. Forums such as websites, conferences, meetings, social media, will greatly stimulate students and will facilitate their interaction with experts.

2.3.1. Forums developed by STAR

The Radioecology Exchange (www.radioecology-exchange.org) was created in 2011 under the STAR NoE, but has become the web resource for activities done not only in STAR but also in the COMET project and in the ALLIANCE (Figure 2). The Radioecology Exchange is intended to become a 'gateway' for information related to European (and wider) radioecological research. Resources that are or will be hosted on this portal include: Virtual laboratory; Education and Training Platform, the Strategic Research Agenda, Observatory Sites information. The Radioecology Exchange also maintains a News blog which is regularly updated by STAR and COMET partners with details of upcoming conferences, training courses, jobs, studentships and publications by partner institutes, as well as the outputs of STAR and COMET projects.

The Radioecology Exchange will ultimately be maintained by the ALLIANCE (www.er-alliance.org).

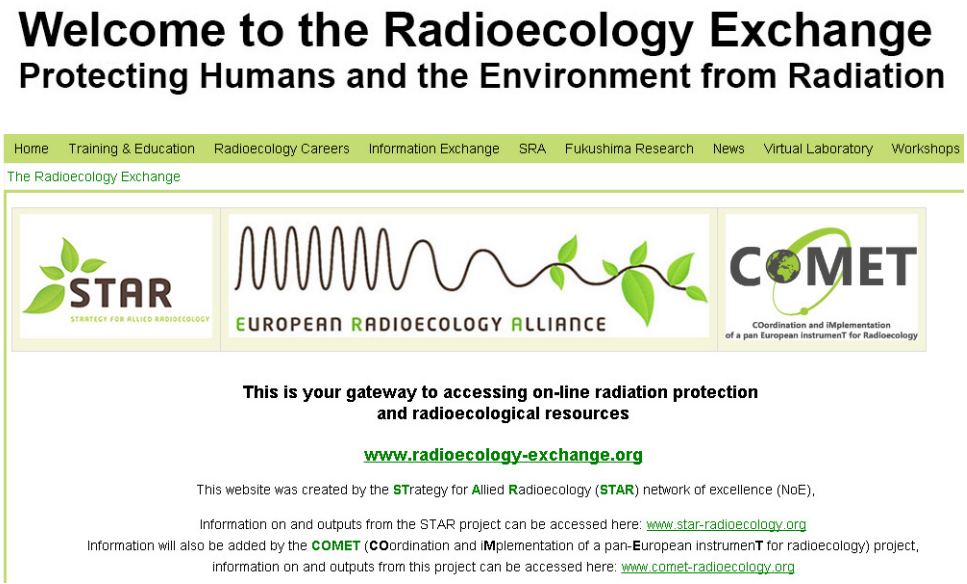

Figure 2: The Radioecology Exchange web portal (www.radioecology-exchange.org).

Several workshops and courses have been organised within the STAR NoE (see Section 3), where students have had the opportunity to interact with experts, as well as to express their concerns, opinions and needs. In addition, STAR organised a special Open Forum during the International Symposium on Environmental Radioactivity organized by Plymouth University in September 2012, entitled "*Postgraduate Initiatives in*

Radiobiology and Radioecology: Present and Future". In this open forum the opinion from many PhD students on a range of questions distributed in advance, were discussed. The main issues and suggestions raised during the discussion sessions included:

- A lack of facilities and training at some organisations sometimes make it difficult to progress in postgraduate studies, particularly regarding broader goals and skills.
- Placements and lab exchanges could be a way forward to enhance knowledge and skills.
- Specific courses on for example writing grant proposals, statistical calculations and data handling and radiotracer techniques, could be useful.
- Specialist courses would further benefit either from giving credits within the Bologna framework and/or providing some kind of recognised certification.
- Courses could also be organised in conjunction with national (e.g. annual COGER meeting in the UK) or international conferences.
- It was suggested that although online forums are useful, people still very much valued face-to-face meetings. One suggestion was to have a postgraduate meeting that rotated between the various national radioecology/radiobiology societies (e.g. COGER in the UK, SFREK/SFR/SweRays in Sweden, etc.).
- It was suggested that online forums were a good way to get advice and ask questions from others in the field. More could be done to increase interest and exchange information in environmental radioactivity by blogging. However, it was noted that blogs, online forums etc. are only successful when they are regularly used and/or read by a critical mass of people. It was also mentioned that an email-list can often be just as useful.
- University careers advice services were often poorly equipped to advise students in specialist areas. Students could benefit if each department had a specialist contact for the careers service. This provision is available in some institutions (e.g. Imperial College London).
- Scientists should engage with funding agencies (e.g. research councils) in order to highlight the need for PhD students to maintain the skill base in this area.

Social media: Twitter and Facebook. Within the timeframe of STAR both a Twitter account and a Facebook page on Radioecology and Environmental Radioactivity have been provided. Here people interested in following science news or information on courses and education within radioecology can get information and even interact. Currently, there are 215 people liking the Facebook page and 90 followers on Twitter.

The Twitter account can be found at @STARadioecology and the Facebook page is found at https://www.facebook.com/radioecology with the name "Radioecology/Environmental Radioactivity". The Twitter and Facebook is also linked together to ensure that the same information is to be found in both places.

Both, the Twitter account and the Facebook page, will remain active once STAR ends, linked to "The Radioecology Exchange".

2.3.2. Forums available in Europe and Internationally

EURAYS is a European association founded to help and support young scientists working in the field of radiation research, focussing mainly, but not only, on low dose risk (www.eurays.eu) (Figure 3).

Figure 3. The EURAYS web page (www.eurays.eu)

The goals of EURAYS include:

- To create a network/community of young scientists to promote and facilitate career development within the radiation sciences.
- To support and facilitate scholarly exchange, interdisciplinary communication and establish collaborations, including research training amongst different laboratories across Europe.
- To support and facilitate the participation of members at national and international schools and training courses.
- To encourage the active participation of members at radiation science relevant meetings.
- To establish collaborative links and awareness of European radiation research projects and other societies for young scientists in radiation research.
- To have a link between the young scientist community and the decision making bodies of European Projects.

There are 130 members and membership is free. Currently the network is mostly a way to spread information via the website, newsletter, Twitter and LinkedIn group. In the long term, they want to be able to provide travel grants, although at the moment they do not have the funding mechanisms to do so.

The origin of EURAYS was the Swedish network **SWE-RAYS** (http://www.swerays.se/), a network for PhD students and junior researchers active in radiation-related research in Sweden, where "young" refers to the stage of the career and not the age of the scientist.

The aims of the network are to promote collaboration between the research groups active in Sweden, and to promote career finding and career development for young scientists (focusing on PhD students and post-docs). It organises a yearly workshop.

International or national conferences, workshops and seminars are additional important forums where students could get in contact with experts. It will be very useful to have in future "meeting points" in big radioecology events (for example ICRER, ERR conferences, etc.), where students could interact and share their experience.

To motivate students, several organizations grant awards for young scientist, as for example the European Radiation Research Society (http://www.errs.eu/) or the International Radiation Commission: Research into Atmospheric Radiation. (http://www.irc-iamas.org/about.php).

3. Evaluation of the education and training programme in radioecology

Already during the EURAC project it was demonstrated that there was a significant need for appropriately skilled postgraduates and in consultation with stakeholders the EURAC project identified three European Masters programmes – MSc in Radiological Protection, MSc in Radiochemistry and MSc in Radioecology – that would meet these needs. Surveys showed that despite only 4 MSc level courses being available in radioecology, compared to 17 in radiation protection, the discipline was as widely sought after by government and research employers.

As has been described in Section 2.1 of this Deliverable, as part of the STAR Mobility, Training and Education work package (WP6) two stakeholder workshops were held to focus on the recruitment needs within radioecology. The conclusion was that knowledge of radioecology was likely to be needed well into the future, by industry authorities and regulators, since research forms the basis of much regulatory work. The need for such knowledge is justified by the many different ways that radionuclides may be released into the environment: nuclear weapons tests, legacy nuclear sites, nuclear fuel cycle, nuclear accidents, on-going activities, waste disposal, clean-up and remediation, hospitals and other non-nuclear industries. This all pointed to a series of research areas where recruitment was needed, covering most of radioecology, and including the urban environment.

The STAR workshops also addressed the question of which course curriculum, syllabus and modules might form the basis of MSc, PhD and worker training within radioecology. The MSc course in particular should be scientifically based and also contain components that will attract the interest of a variety of different students, building for example on the exoticness of nuclear physics, controversy from accidents and the environmental, ecological and political aspects. The challenge is obviously to adequately cover all this in a mere 10 ECTS course, but some possible themes can also be developed into specialist or training courses. Based on the outcome of these workshops the STAR NoE developed the E&T platform, as well as courses focused on the needs within radioecology (STAR Deliverable 6.2 and Sections 3.1 and 3.2 of this Deliverable).

3.1.MSc programme in Radioecology

The only MSc in Radioecology existing in Europe has been established at the Norwegian University of Life Sciences (NMBU). Students from within Europe and outside have attended individual course modules or the whole MSc programme. Expert teachers are also from institutions from different countries in Europe and in North America. Initiatives have been taken to establish a Joint MSc degree between universities in Europe.

At the moment, the EU MSc in Radioecology is a tailored two year, Bologna accredited (120 ECTS) MSc programme consisting of obligatory and voluntary stand-alone course modules. The MSc is presently hosted at the NMBU, where students can take all necessary courses if they wish. But, as for any EU MSc, students are free to obtain credits

by taking ECTS accredited courses at other institutions and collaborating universities (e.g. Aix-Marseille, University of Oslo, Moscow State University).

Evaluation of the MSc Programme. For the future, the radioecology courses could benefit from more interaction with other E&T platforms already available. Already today some courses in the MSc in Radioecology are linked to other EU education and training initiatives like CINCH-II (Nuclear chemistry) and DoReMi (Radiobiology). These courses grant ECTS credits and have become popular, with attendants recommending these courses to others, and thus there have been no problems in recruiting enough participants. Building up on this experience the programme should be expanded offering similar courses on radioecology topics. This enables a more cost effective use of the resources already invested in on-going courses and facilities in Europe.

To increase the number of European students enrolling into the programme, there is a need for a more extensive advertising at all collaborative universities and institutions. A sustainable funding system for both teachers' and students' mobility is also needed to ensure the use of common courses and facilities at the collaborating universities/ institutions.

In the future, it would be beneficial to have a signed Memorandum of Understanding between all the involved Universities, to facilitate student access to the courses. To be able to build an MSc in Radioecology, if and when course modules follow the Bologna convention standards, a joint degree between collaborating universities would boost the EU MSc programme and student access throughout Europe.

3.2. STAR Education and training courses

A total of four courses were given within STAR WP6 (one MSc course, one PhD course and two professional development training courses) aiming to meet some of the needs within radioecology. The restructuring and development of the courses has benefited from the input of both the STAR participants and the STAR E&T stakeholders (see STAR Deliverable 6.1). In addition to these planned courses, other courses have been held including web-based courses on Biological Ligand Model (BLM) and mixture toxicity. A new course module in modelling has also been prepared. The courses provided by STAR, as well as courses available in the STAR consortium, give the students access to more specialized courses to choose from, building their specialized Radioecology MSc or PhD. All STAR courses are described in detail in STAR Deliverable 6.3.

The courses aim not only to fill the identified European postgraduate education gap in radioecological sciences, but also to provide a modular structure that is easily accessed by stakeholders for professional development training. It was anticipated that the European Masters course would provide the academic training such that students can be considered "qualified experts", as defined by the European Commission and the IAEA.

The following intensive modules have been or will be provided by the STAR consortium:

- MSc Experimental Radioecology
- PhD Environmental Radiobiology

- STAR Mixture Toxicity, Dynamic-Energy-Budget (DEB) and risk assessment – a training workshop
- Radiological Protection of the Environment - a professional development training course on the ERICA tool

The courses attracted students from different countries and included PhD students, MSc students and the evaluation and feedback by the participants was overall very positive.

3.2.1. The MSc course in Experimental Radioecology

The MSc in experimental radioecology is the STAR "flagship" radioecology course intended to be accessible to students taking other environmental science and radiation related subjects, as well as to professionals wishing to build up their competence. At the present time, the course is held at NMBU as part of the Radioecology MSc, and has been developed within STAR from earlier versions of the course that have been offered to NMBU students since the early 1990s.

Although the course to be offered as part of the STAR project was scheduled for autumn 2013, based on input from the STAR E&T stakeholder workshops and STAR consortium discussions, some changes were already made to the course for 2012. This included addition of other international and STAR specialists from IRSN, McMaster University and NRPA. The 2013 courses attracted 11 students, of whom 7 followed the full 10 ECTS course, and passed the exam, while 4 passed the exam for the 5 ECTS course. All the course students were recruited from the Consortium members, with local NMBU students representing 50%. Further developments have been made for the 2013 and 2014 courses. These include increased teaching participation from STAR Consortium members (SCK·CEN, CIEMAT, NRPA and IRSN).

Evaluation of the course: Feedback from the student course evaluation questionnaire, as well as direct response from students and the experience of the teachers, was positive. Based on a questionnaire answered by the students after the course exam the students thought that the course in all was interesting and good with an average score of 5.88 (where 6 is the best), with lectures scored 5.13 and laboratory practices scored 5.63. The teachers scored on average 5.63 while the course scored 5.75 on communication. The presence of top specialists as teachers and a good mix of lectures and laboratory exercises were highlights of the course.

The only criticism was the high intensity of the lecturing hours, which might be hard to change given the short time frame for an intensive course. The course was deliberately intensive to make it easier for professionals and foreign students to attend. The feedback from students and teachers has as far as possible been taken into account for the 2013 and 2014 courses.

3.2.2. The PhD course in Environmental Radiobiology

The Environmental Radiobiology course was the test PhD course run during the STAR project. The aim of the course was to give students an overview of the fundamental principles of radiobiology, but within the context of effects on non-human biota. The course covered both the history and the state-of-the-art of our knowledge on the biological effects of radiation on humans, including how recent studies are challenging established

paradigms, but concentrated specifically on those issues and applications of most relevance for other organisms. This included effects and endpoints significant for non-human organisms, ways in which radiobiology methods and biomarkers are being applied in ecological research, factors influencing radiosensitivity in different organisms, and ecological risk assessment. Case studies included ecological research in Chernobyl and Fukushima, and laboratory work on biomarker analysis in model organisms.

In a development from the original STAR work plan, we made a successful application for additional funding from the DoReMi NoE for this course for 2013, primarily to foster exchange of students between the two disciplines, and also to strengthen links with the radiobiology community. The rational was that the course would provide the opportunity to get a better understanding of the fundamentals of radiobiology for students of radioecology; and that for radiation biology students it would offer the chance to see how radiobiology concepts and tools are applied in other areas of radiation research, thus gaining a more in depth understanding of the subject. Teachers were from Norway, Canada and Sweden and 28 students took the course with a split of 20 PhD and MSc students and 8 "professionals"; of whom 8 were from Norway, 15 EU and 5 non-EU (USA, Argentina and Russia).

The evaluation of the course: The evaluation form was not in the form of a "scoring sheet", but a form where students were asked to comment specifically on the individual lectures and group study sessions, choose the most useful/interesting talks and offer suggestions for improvement of the course. Nearly all lectures were somebody's favourite (with the biomarker and field study cases getting the overall highest scores). General comments included suggestions for including more laboratory training, and an extra introduction day in radiobiology for those coming from outside the field.

3.2.3. STAR Mixture Toxicity, DEB and Risk Assessment Workshop

The workshop aimed to introduce some of the approaches and methodologies used in studying and predicting mixture toxicity effects. This workshop intended to attract PhD students and researchers that are now confronted with the challenges of assessing or predicting biological effects in mixed exposures situations. As the general concepts discussed in the workshop apply to different fields of research, the course was open not only for people within the consortium but also to participants of all fields of (eco)toxicology.

Lectures were given by five lecturers, one from SCK•CEN and two from IRSN, and from outside the consortium one from the Free University-Amsterdam (The Netherlands) and one from RIVM (The Netherlands). In total 9 participants from 6 different countries enrolled, 2 students from Belgium, 3 students from Norway, 1 from Italy, 1 from South-Korea, 1 from Austria and 1 student from France. The course was attended by PhD students as well as post-doctoral scientists. Only 1/3 of the participants were STAR members, others came from research institutes, universities or private companies.

Evaluation of the workshop: Feed-back on the course was given through a questionnaire and directly by the participants and teachers. In general participants were very satisfied with the concept and the organisation of the course. Seven out of the nine students judged the workshop to be "excellent".

3.2.4. Radiological Protection of the Environment - a professional development training course

Under funding from the Natural Environment Research Council (UK), STAR partners NERC-CEH, IRSN and SCK•CEN together with the University of Stirling, developed and ran a number of training courses on radiological environmental assessment focusing on the ERICA Tool (https://wiki.ceh.ac.uk/display/radex/Training+courses). These training courses have been further developed and have been run as part of the STAR project. The courses are primarily aimed at regulators and industry, and those who may conduct assessments on their behalf. However, the course is also open to PhD. students and other researchers.

The course was structured such that Day 1 provided a basic grounding and Days 2 & 3 went into more detail. The objectives are to ensure that participants: Are conversant with assessment objectives; have a basic understanding of radionuclide transfer, dosimetry and radiation effects; and have the know-how to use the available tools & can interpret the results and understand the implications of how the tools are used.

Evaluation of the course. A questionnaire was distributed to the 18 attendees. Based in the answers given, it can be concluded that the course had very clear objectives, it was well structured, its content was relevant and the material covered was very interesting for participants In relation to the practical sessions of the course, the attendees found them very interesting and considered that they were a good help to understand the material presented in the course. In addition participants thought that sufficient guidance was given to enable them to carry out the exercises and that there was a good balance between the presentations and the practical exercises. In summary, the participants thought that the course fulfilled their expectations.

4. Mobility strategy for profitable use of expertise, resources, facilities and infrastructures.

Within the STAR NoE, researchers and students mobility has been a central point of attention. Collaboration on E&T stimulates mobility at all levels. Mobility is an essential means to support competence building within radioecology or any field of science. It enables knowledge exchange and mutual access to facilities and infrastructure, as well as ensuring an optimized use of resources and promoting integration between partners.

4.1. Mobility funding opportunities within the European Union.

The exchange of knowledge and capacity building within European Research Institutes and Infrastructures (RII) is crucial for Europe to increase its competitiveness worldwide. Staff mobility can make significant contributions that lead to the acceleration of capacity building, improvement of staff employability, absorption of peak work-loads and assurance of the availability of suitably qualified professional project teams. The increased interaction and involvement in the exchange of experience and know-how in all domains is of benefit to both the involved parties and the research community as a whole. Having said that, staff mobility between European Research Institutes, on the other hand, appears to be very poor.

The main funding programmes for mobility are:

4.1.1. Marie Skłodowska-Curie actions (MSCA).

Provide grants for all stages of researchers' careers - be they doctoral candidates or highly experienced researchers - and encourage transnational, intersectoral and interdisciplinary mobility. The MSCA enable research-focused organisations (universities, research centres, and companies) to host talented foreign researchers and to create strategic partnerships with leading institutions worldwide. The MSCA aims to equip researchers with the necessary skills and international experience for a successful career, either in the public or the private sector. The programme responds to the challenges sometimes faced by researchers, offering them attractive working conditions and the opportunity to move between academic and other settings.

Types of MSCA:

- **Research networks**: support for Innovative Training Networks (ITN). The ITNs support competitively selected joint research training and/or doctoral programmes, implemented by European partnerships of universities, research institutions, and non-academic organisations. The research training programmes provide experience outside academia, hence developing innovation and employability skills. ITNs include industrial doctorates, in which non-academic organisations have an equal role to universities in respect of the researcher's time and supervision, and joint doctoral degrees delivered by several universities. Furthermore, non-European organisations can participate as additional partners in ITNs, enabling doctoral-level candidates to gain experience outside Europe during their training.

- **Individual fellowships (IF)**: support for experienced researchers undertaking mobility between countries, optionally to the non-academic sector: Individual Fellowships support the mobility of researchers within and beyond Europe - as well as helping to attract the best foreign researchers to work in the EU. The grant usually covers two years' salary, a mobility allowance, research costs and overheads for the host institution. Individual researchers submit proposals for funding in liaison with their planned host organisation. Proposals are judged on their research quality, the researcher's future career prospects, and the support offered by the host organisation. Fellows can also spend part of the fellowship elsewhere in Europe if this would boost impact, and those restarting their career in Europe benefit from special eligibility conditions.
- **International and inter-sectoral cooperation through the Research and Innovation Staff Exchanges (RISE)**: RISE supports short-term mobility of research and innovation staff at all career levels, from the most junior (post-graduate) to the most senior (management), including also administrative and technical staff. It is open to partnerships of universities, research institutions, and non-academic organisations both within and beyond Europe. In worldwide partnerships, academia-to-academia exchanges are permitted.
- **Co-funding of regional, national and international programmes that finance fellowships involving mobility to or from another country**: The MSCA offer additional funding to regional, national and international programmes for research training and career development. COFUND programmes encourage the movement of researchers across borders and provide good working conditions. The scheme can support doctoral and fellowship programmes.

The current mechanism - Marie Curie Fellowships - meets many of the needs for researcher mobility but is limited by scope and procedures for many of the specific needs of a research institution or research infrastructure. Specifically, the present target for the allocation of Marie Curie fellowships is too narrow to match the broader, more project-oriented and operations-related needs and the time required to complete the Marie-Curie process (call/evaluation/negotiation) is incommensurate with the urgency of the needs of the institutions. The incentives needed to promote mobility are also limited. A wide gap exists between the current situation and that needed to promote and facilitate the exchange of expertise between European Research Institutions (RI) and Infrastructures

In Europe, it is proposed to establish a **Europe-wide secondment-based scheme for staff mobility** within an integrated structure of European RIs covering one or several research communities. This would provide a solid framework within which staff mobility could occur, individual experts could follow a career path across a wide range of RIs and career development within a group of RIs, rather than within a single RI, could be envisaged (http://www.eiroforum.org/downloads/201111_mobility_proposal.pdf).

A financial scheme should be established to support this secondment-based mobility. It is proposed to include a specific set of accompanying measures:

- A set of financial measures that include a living allowance and the reimbursement of removal expenses; exceptional solutions may be considered to cover education expenses or the loss of a partner's job; existing European-level financial rules should be examined for applicability;

- An additional funding mechanism should be established to provide the budget needed to cover the supplementary costs associated with these measures.

Such a scheme for staff mobility will facilitate the exchange of those suitably highly qualified experts within European Member States. The scheme has four significant impacts:

- Clear added-value not only for the sending and receiving RIs and the secondee, but also for the community as a whole in the exchange of knowledge and capacity building opportunities.
- The scheme may also be attractive to young researchers who often take up post-doctoral research positions in European RIs outside their home countries.
- This scheme may ultimately stimulate the knowledge transfer between the facilities and the industry.
- Increased mobility may extend the influence of European RIs beyond the boundaries of the European Research Area, establishing a new equilibrium between Eastern and Western European countries and progressively integrating European border countries (IPCP, Mediterranean Partner Countries) using support from EU neighbouring policies.

4.1.2. ERASMUS+ Key Action 2 (KA2).

Offers the opportunity to make it possible for organisations from different participating countries to work together, to develop, share and transfer best practices and innovative approaches in the fields of education, training and youth. The following actions are managed by the EACEA as part of the General call for proposals and described in detail in the Programme Guide:

- Knowledge Alliances cooperation between higher education institutions and enterprises;
- Sector Skills Alliances supporting the design and delivery of joint vocational training curricula, programmes and teaching and training methodologies;
- Capacity Building in the field of youth supporting cooperation with Partner Countries;
- Capacity Building in the field of higher education supporting cooperation with Partner Countries.

Additionally there will be a high number of Strategic Partnerships in the field of education, training and youth supported through KA2. The selection and the management takes place at national level and information needs to be found at the National Agency in each country.

The Actions supported under this Key Action are expected to bring positive and long-lasting effects on the participating organisations, on the policy systems in which such Actions are framed as well as on the persons directly or indirectly involved in the organised activities. These Key Actions are expected to result in the development, transfer and/or implementation of innovative practices at organisational, local, regional, national or European levels. For more information, see the ERASMUS+ Programme Guide (http://goo.gl/vCcywu).

4.2. Mobility and collaboration within the STAR NoE

STAR partners have expertise in wide range of areas of radioecology and radioanalytical methods. The network partners bring together not only radioecology expertise but also leading expertise in biology, ecotoxicology, ecology, radiobiology, modelling, and E&T. The STAR NoE is also highly resourced when it comes to specialized facilities and research equipment, what highlights the ability of the STAR network to perform high quality radioecological research. The facilities comprise different kinds of laboratories, such as rooms for pre-treatment of samples, specially constructed experimental systems for radioecological and radiobiological studies and measurement, specialized equipment for radioactivity measurements, radiochemical and biological treatment of samples and a variety of organisms (animals and plants).

Within the STAR NoE an inventory of infrastructures has been developed, including facilities, methods, equipment, models, expertise, databases and sample archives. This infrastructure database will help ensure effective collaboration and integration between the partners, with the possibility to enlarge to other radioecology institutes in Europe and worldwide (STAR Deliverable 2.2). The content of the database will be crucial to promote the mobility of researchers and students between the different organizations and will serve as a resource for education and knowledge transfer. In addition, the infrastructure database will contribute to: avoid overlapping efforts and thus increase efficiency; exploit synergistic interfaces; identify gaps and weaknesses in European infrastructures.

The infrastructures database is included in the virtual laboratory that is under creation in The Radioecology Exchange web portal (www.radioecology-exchange.org) (STAR Deliverable 2.4) (Figure 4).

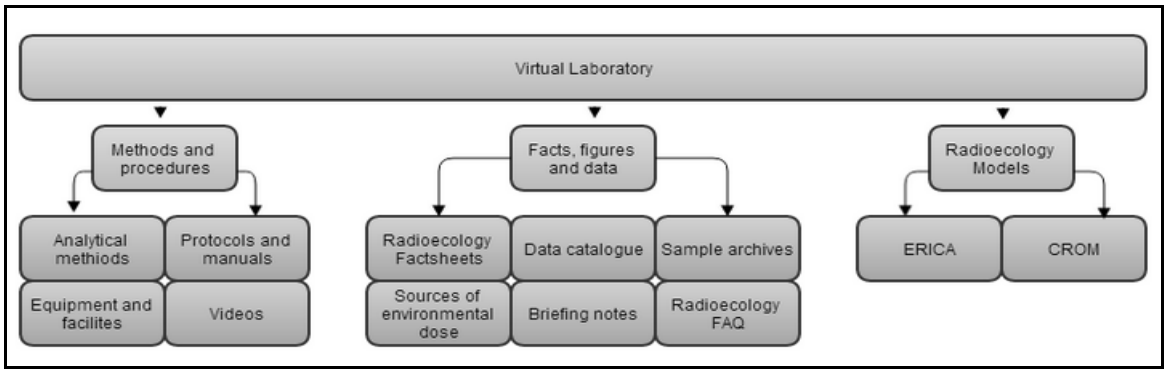

Figure 4. Structure of the Virtual Laboratory (http://goo.gl/gh7ny9).

The virtual laboratory was created during the STAR Project and will be extended in the future to include information from COMET and ALLIANCE members. It has a dedicated area on the Radioecology Exchange and contains among other resources:

- Information collated during the STAR project about the facilities held at each partner laboratory and how to access them.
- Descriptions of some analytical methods commonly used in radioecology studies (including, in some cases, video clips and the problems likely to be encountered together with possible solutions).

- Protocols and manuals used during STAR experiments.
- A catalogue of databases held by STAR partners and how to access them.
- Outputs from EURATOM projects – reports and deliverables from many EC funded projects related to radioecology have been compiled to facilitate easy access.
- A list of the sample archives held by STAR partners and how to access them.
- An overview of two assessment models: CROM (human exposure) and ERICA (wildlife assessment).

The virtual laboratory will also provide on-line demonstrations of procedures and wiki blogs to enable interactive communication. It will encourage integration through better planning of joint research projects, joint use of infrastructure, and establishing best practices.

The STAR NoE has initiated integration processes and established mechanisms to ensure long term sustainability of the virtual laboratory. In the future, the infrastructure database and the virtual laboratory will be useful for exploring the potential for collaboration between COMET, ALLIANCE and other research organisations, international organizations (e.g. IAEA, IUR) and other platforms (NERIS, MELODI, EURADOS).

To promote mobility within STAR NoE, a mobility stimulus budget was included in the project. The mobility stimulus budget has facilitated active collaboration and integration between STAR partners, by supporting exchange of scientists and students between partner institutions. The types of activities planned to be covered by these funds include:

- joint experiments, training and field studies,
- hosting and joint supervision of students,
- exchange visits,
- providing internships and work experience placements,
- providing training to students and scientist (knowledge exchange).

The mobility funds within STAR have made it possible for several PhD students and post docs to take part in common experiments at partner institutions. The timing of the stays has been from 1 to 4 weeks. Without these mobility funds if would have been more difficult to do any integrated collaborative work within STAR. The mobility funds have given the PhDs and post docs opportunities to participate and collaborate in common experiments, be part of important knowledge exchange and increase their professional network. This should give huge advantages for their future careers but also for each of the collaboration institutions to further develop collaboration towards future scientific work. Staff mobility brings clear benefits to all the parties involved.

During the STAR NoE, the following mobility actions have taken place:

PhD students mobility:

Experimental work

- Adrien Margerit (IRSN) attendance in joint experiments with CEH in Wallingford in May 2012.

- Adeline Goussen (IRSN) attendance in experiments at the g -irradiation facility of SCK•CEN in January 2013 and November-December 2013.

Participation in courses:

- Arne van Hoeck (SCK·CEN). STAR Environmental radiobiology course at NMBU (June 2013).
- Shinichiro Uematsu (SCK·CEN) followed the Master course in Experimental Radioecology at NMBU (October 2013).
- Anna-Lea Golz (SU). STAR MSc course Experimental Radioecology at NMBU (autumn 2014).

Researchers mobility:

- Sandrine Peirera (IRSN, Post doctoral), visited SU for experiments at the g-irradiation facilities (September 2012).
- Clare Bradshaw (SU, researcher) and Francisco Nascimento (SU, postdoc), visited the SCK•CEN lab (Mol) to perform a mixture toxicity experiment at their gamma irradiation facility (January 2013 and December 2013). Isak Holmerin (SU assistant) also visited Mol in December 2013.
- Christine Willrodt (BfS, researcher), visited SCK•CEN lab (Mol) to perform experiments with Lemna (February 2013 and March 2013).

Teaching in STAR courses:

- Clare Bradshaw (SU researcher). Environmental Radiobiology course at NMBU (June 2013).
- Clare Bradshaw (SU researcher). Assessing Risk to Humans and the Environment at NMBU (June 2014).
- Hildegarde Vandenhove (SCK·CEN researcher). Experimental Radioecology course at NMBU (2013 and 2014.
- Frederic Alonzo (IRSN researcher). STAR course on DEBTox - Mixture at SCK·CEN (January 2014).

5. Available and potential funding mechanisms to support sustainability of education, training and mobility within radioecology

5.1.National opportunities

5.1.1. Belgium

Fund for Scientific Research - Flanders (FWO) (http://www.fwo.be/en/) and its Wallonian counterpart Fund for Scientific Research - Wallonia (FNRS) (http://www.fnrs.be/en/) are two sister institutes in Belgium, granting fellowships for education and for international mobility (http://www.fwo.be/en/fellowships-funding/international-mobility/). In addition there exists in Flanders the Agency for Innovation through Science and Technology (IWT, http://www.iwt.be/english/welcome) which is also a government agency that supports funding of PhD and Postdoctoral grants for basic research with an economical finality.

Fellowships for education

- **PhD fellowship**. Is the most important funding channel to prepare young and promising researchers to complete their PhD. PhD fellow ships are given by all three organisations. For FWO and FNRS the PhD research must be fundamental in nature whereas for IWT an economical finality is asked for. For the funding of a limited number of fellowships, the FWO collaborates with SCK•CEN, L'Oreal-Unesco and VITO.

- **Special PhD fellowship (FWO/FNRS).** Enables persons not employed within scientific research to complete a PhD within one year. Applicants must be in possession of a "temporary leave" certificate issued by their current employer.

- **ICM-FWO Fellowship.** Is a specific funding channel to prepare young and promising researchers to complete their PhD based on high-quality research in the field of management sciences, from various basic disciplines, interdisciplinary and practice-oriented.

- **Postdoctoral fellowships** are intended to support researchers who have only recently completed their PhD, in developing an independent, international research career funded through FWO/FNRS

- **Innovation mandates** funded by IWT, are also postdoctoral research fellowship with special focus on deploying active efforts to achieve the effective transfer, the exploitation and the utilisation of the research findings, either through a collaboration with an existing company, or a new spin-off company to be established.

Fellowships for international mobility

- **Grant for participation in an international conference (FWO/FNRS).** This grant supports researchers who wish to participate in an international scientific conference.

The grants are awarded only for conferences of a purely scientific nature, featuring speeches and discussions of original contributions or reports.

- **Travel Grant for a short stay abroad (FWO/FNRS).** This grant supports researchers who wish to spend a short period abroad to further specialise in their area or to undertake knowledge-gathering assignments. In this way, the FWO aims to encourage mobility and international contacts between research groups. These grants offer young researchers the opportunity to specialise in their area of interest. Senior researchers are given the opportunity to undertake knowledge-gathering assignments abroad.

- **Grant for participation in an international workshop or course (FWO/FNRS)**
  This grant supports researchers who wish to participate in an international course or workshop that gives them the opportunity to further specialise in their area of interest. The grant covers the travel expenses in order to encourage mobility and international contacts between research groups. The grants are intended for young researchers affiliated to a Flemish university or institution for scientific research.

- **Travel Grant for a long stay abroad. (FWO/FNRS)**This grant supports researchers who will be staying abroad for at least 5 weeks and at most 12 months for research purposes. In this way, the FWO aims to encourage the mobility of researchers.

5.1.2. France

In France, many funding mechanisms are available at the national level, in addition to the European mechanisms, to promote mobility of young researcher (either PhD or Post-doctoral researchers). However, they are provided by a huge amount of various organizations including foundations, academic institutions (universities, ministry), or professional associations. Examples with web linked are provided below for these three categories:

- Foundations:
  - The L'Oréal Foundation awards doctoral or post-doctoral researchers in the life sciences to enable them to widen their scope of expertise at recognized research institutions outside their home countries (http://goo.gl/I46waK).

- Academic institutions:
  - The French ministry in charge of the Higher Education and Research (http://goo.gl/0TJPxr).
  - The Agence Universitaire de la Francophonie (http://www.auf.org).
  - The French national agency for the promotion of higher education, international student services, and international mobility (http://www.campusfrance.org/en).
  - The Normandy's doctoral School of Integrative Biology, Health and Environment (EdN BISE 497) of Caen university (http://www.unicaen.fr/ednbise/Accueil).
  - The doctoral school for Environment and Health of Bourgogne and Franche-Comté universities http://www.ecoledoctoralee2s.com/bourses-de-mobilite.html

- The Auvergne University Foundation (http://www.fuda.fr/encourager-l-excellence-de-la-recherche.html)

- Professional associations of interest for radioecology:
  - The French association for soil study (AFES) (http://www.afes.fr/bourses.php).
  - The French Society for Electrophoresis and Proteomics Analysis (SFEAP) (http://www.sfeap.fr/index.php?rub=bourses).
  - The French Chemical Society (SCF) (http://www.societechimiquedefrance.fr/).
  - The Society for Biology of the Cell - France (SBCF) (http://goo.gl/bjCYjO).

Very few sites try to compile all the available information, some are given below:

- The site of the "Initiances" association (http://www.iedu.fr).
- The site of the "French doctor association" (ANDES) (http://www.andes.asso.fr).
- The site of the Bernard Gregory association (ABG) (http://www.intelliagence.fr/).

5.1.3. Germany

In Germany, there are different funding possibilities for education and training:

DAAD - German Academic exchange service is the biggest German provider of studentships in Germany; funding German students, postgraduates to study abroad or applying for internships or German university lecturers. DAAD is also offering scholarship options for foreigners coming to Germany to study, to lecture or to complete an internship (http://goo.gl/VlZClj).

Bavarian Research Fund gives funding to two types of projects: individual ventures and combined research; in addition, scholarships are provided for scientist exchange programmes. The duration of the funding is limited, and the projects must be jointly carried out by science and industry. The goal is to create economic value from the research results of main focus areas such as life sciences, information and communication, microsystems engineering, materials science, energy and the environment, mechatronics, nanotechnology, and process and production engineering (http://goo.gl/2qNuUY; http://goo.gl/3E2R82).

DFG: Research Fellowships for young scientists (post PhD): Proposal Requirements: High scientific quality and originality of a research project at an international level (http://goo.gl/7S0v3B).

Eidam & Partner funds: The Company offers worldwide services related to cross-cultural communication (http://www.eidam-und-partner.de/Stipendium).

Conditions:

- Each semester a studentship of 450 € per month is provided for 15 German students. Students may only apply, if they are presently studying at a German university taking master courses or as equivalent will graduate with a university diploma.
- The funds will be paid either for attending a university or an internship abroad.
- The maximum funding period is 6 months.

- Every stipendiary will receive an intercultural training by the funding company free of charge.
- The studentship will be completely financed by the company and is not to be paid back.
- There are no limitations concerning the targeted country not the university or internship providing agency.
- There are two fixed application periods: July [for the summer term of the following year] and January [for the next winter term].

5.1.4. Norway

The Research Council of Norway has had several projects within scholarships, mobility and recruitment, but is now in the process of concluding several of its support schemes for individual researcher mobility to pave the way for a more strategic, targeted use of mobility funding.

The YGGDRASIL mobility programme for incoming researchers from Europe to Norway, the Leiv Eiriksson mobility programme for researcher exchange between North America and Norway, and the E.ON (formerly E.ON Ruhrgas) scholarship programme for research cooperation between Germany and Norway are all now being terminated in their current form.

Support for mobility between Norway and North America will be continued via funding announcements for Grants for Long-term, International, Institutional Cooperation (LISI), a new activity being launched at the Research Council.

The Research Council's various programmes and activities have designated mobility funding in a variety of areas.

- Marie Curie Actions (MCA) are a funding instrument for researcher training and mobility under the "People" Programme of the EU Seventh Framework Programme.
- Industrial Ph.D. Scheme - Up to NOK 1 million has been set aside for 2013 for overseas research grants for projects receiving funding under the Industrial Ph.D. Scheme.
- EURAXESS Norway provides practical information and assistance for Norwegian researchers who will be undertaking a research stay abroad and foreign researchers and their host institutions prior to and during a research stay in Norway. The site also advertises vacant positions.
- The mobility funding database provides information about who can apply, what can be applied for and how much funding may be received under the mobility funding opportunities from the Research Council of Norway and other actors. The database covers primarily scholarships for incoming and outgoing researchers between Norway and its priority partner countries for research, including EU member states.

For more information on possibilities through Norwegian Research council, see http://goo.gl/tAhjyN).

The Norwegian Centre for International Cooperation in Education (SIU) is a Norwegian public sector agency that promotes international cooperation in education and research.

SIU is a knowledge- and service organisation with the mission of promoting and facilitating cooperation, standardisation, mobility, and the overcoming of cultural barriers to communication and exchange within the realm of education on an international level. The centre is charged with the important task of coordinating national measures according to official Norwegian policy within the field of internationalisation.

The centre is Norway's official agency for international programmes and measures related to education. It is commissioned by several national and international public organisations to administer programmes within all levels of education.

In addition to programme administration, SIU is responsible for promoting Norway as an education and research destination, as well as providing information and advisory services within the field of internationalisation in education.

SIU is funded through assignments from:

- The Norwegian Ministry of Education and Research (KD)
- The Norwegian Ministry of Foreign Affairs (UD)
- The Norwegian Agency for Development Cooperation (Norad)
- The Nordic Council of Ministers
- The Commission of the European Community
- Norwegian Directorate for Education and Training

More information can be found at the http://www.siu.no/eng

5.1.5. Spain

Within the Ministry of Economy and Finance, in the General Secretary for Research, Development and Innovation, there is the "National Plan for Scientific and Technical Research and Innovation", which includes the "National Programme for the Promotion of Talent and Its Employability", which has the following subprogrammes:

- State Subprogramme of Training:
  - Grants for pre-doctoral training contracts of doctors
  - Grants for enrolment in doctoral programmes of research trainees
  - Grants for PhD Severo Ochoa contracts for the training of doctors
  - Helps Juan de la Cierva-training
  - Helps contracts for the training of researchers in companies (Industrial Doctorates)
- State Subprogramme of Incorporation:
  - Helps Ramón y Cajal contracts (RYC)
  - Helps contracts Technical Support Staff (PTA)
  - Helps Juan de la Cierva-incorporation

- Aid for the recruitment and training of technologists to carry out R+D+i in enterprises
- Helps contracts Torres Quevedo (PTQ)
- Helps promote youth employment and implementation of the Youth Guarantee in R+D+i.

- State Subprogramme for Mobility:
  - Helps for the pre-doctoral mobility for conducting short stays in R&D Centres, birth in Spain and abroad

All the information about the Programme and the Subprogrammes is available in http://goo.gl/0xuQxf.

Some private foundations, as for example IBERDROLA Foundation, grant fellowships for postgraduate studies in energy and the environment in Spain (http://goo.gl/qM5YLG). It is not easy to find the information about the fellowships granted by the private foundations, because there is not a web portal containing this type of information.

5.1.6. Sweden

Many PhD and postdoctoral positions are funded through the main government funding agencies: the Swedish Research Council VR (www.vr.se) and the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, Formas (www.formas.se). These both have schemes to enhance mobility for postdoctoral and other scientists and special programmes for bilateral and multilateral collaborations. For example, Formas has a postdoc scheme called 'Mobility starting grants for young researchers' where young researchers must spend at least a third of their time at a different institute to their own. VR funds postdoc positions and international collaborations via a special funding mechanism (http://goo.gl/FxxUEs).

The Swedish Radiation Safety Agency, SSM (www.ssm.se), funds a small amount of research each year within the field of radiation protection, including radioecology. The total budget is around 10Mkr (900k euro) and each project can receive a maximum of 500kkr (55k euro).

There are also numerous smaller funds from a large number or private and public organisations for conference and travel costs and bilateral agreements between particular countries within certain topics. Individual universities also usually have their own specific funds for such purposes.

The Scandinavian countries have a number of joint funding mechanisms, for example through NordForsk (http://www.nordforsk.org/), and Nordic Nuclear Safety Research (http://www.nks.org/). Both encourage or require collaboration between Nordic partners and have specific funds for travel assistance.

5.2. European possibilities through ERASMUS programmes

The EU ERASMUS provides a lot of possibilities for both student and teacher exchange and also cooperation for universities and institutions on common education programmes.

5.2.1. The Erasmus Programme

The Erasmus Programme is an EU exchange student programme that has been in existence since the late 1980s. Its purpose is to provide foreign exchange options for students from within the European Union and it involves many of the best universities and seats of learning on the continent.

The programme is aimed at cross-border cooperation between states to aid the growth of international studying, and with over 4000 students involved in the programme at any one time it offers an excellent chance of experience abroad (http://www.erasmusprogramme.com/the_erasmus.php).

ERASMUS+ is the EU's new programme for boosting skills and employability through E&T. Between 2014 and 2020 the programme will provide opportunities for over 4 million Europeans to study, train, gain work experience, and volunteer abroad. (http://ec.europa.eu/education/opportunities/index_en.htm).

In the field of E&T, the Erasmus initiative is renowned for the opportunities it provides students to learn abroad, as well as the opportunities it provides for teaching staff in higher education.

Building on these, the Erasmus+ programme now covers five major areas of E&T:

- School education opportunities for staff and institutions;
- Vocational E&T opportunities for students, apprentices, trainees, staff, institutions, and business;
- Higher education opportunities for students, staff, institutions, and businesses;
- Adult education opportunities for staff, institutions, and businesses;
- European integration opportunities for academic and research staff and institutions.

Erasmus+ is the EU Programme in the fields of education, training, youth and sport for the period 2014-20201. Education, training, youth and sport can make a major contribution to help tackle socio-economic changes, the key challenges that Europe will be facing until the end of the decade and to support the implementation of the Europe 2020 strategy for growth, jobs, social equity and inclusion.

The Erasmus+ Programme is designed to support Programme Countries' efforts to efficiently use the potential of Europe's human talent and social capital, while confirming the principle of lifelong learning by linking support to formal, non-formal and informal learning throughout the education, training and youth fields. The Programme also enhances the opportunities for cooperation and mobility with Partner Countries, notably in the fields of higher education and youth.

More information on ERASMUS+ can be found in the ERASMUS+ Programme Guide (http://goo.gl/zLbwoH).

The following sections "Key Action 1", "Key Action 2" and "Key Action 3" present concrete Actions that are designed to achieve the Programme objectives in the field of E&T. Among these Actions, the ones mainly -but not exclusively -connected with the field of education and training are:

- Mobility projects for learners and staff in higher education and vocational education and training (VET);
- Mobility projects for staff in school education and adult education;
- Erasmus Mundus Joint Master Degrees;
- Erasmus+ Master Loan;
- Strategic Partnerships;
- Knowledge Alliances;
- Sector Skills Alliances;
- Capacity Building in the field of higher education.

Although there was no time to do it during the STAR NoE, in the framework of other EU programmes in radioecology (for example COMET), the Mobility projects, the Erasmus Mundus Joint Master Degrees, and the Capacity Building should be explored to ensure continuance and sustainability.

5.2.2. Mobility projects for learners and staff in higher education and vocational education and training.

Organisations active in the fields of education, training and youth will receive support from the Erasmus+ Programme to carry out projects promoting different types of mobility. A mobility project will consist of the following stages:

- Preparation (including practical arrangements, selection of participants, set up of agreements with partners and participants, linguistic/intercultural/task-related preparation of participants before departure).
- Implementation of the mobility activities.
- Follow-up (including the evaluation of the activities, the formal recognition - where applicable -of the learning outcomes of participants during the activity, as well as the dissemination and use of the project's outcomes).

An important innovation introduced in Erasmus+ compared to many actions of mobility supported under past European programmes is that Erasmus+ reinforces the support offered to the participants of mobility activities in improving their foreign language competences before and during their stay abroad. Furthermore, Erasmus+, more than in the past programmes, will offer space for developing mobility activities that involve partner organisations with different backgrounds and active in different fields or socio-economic sectors (e.g. traineeships of university students or VET learners in enterprises, NGOs, public bodies; teachers in schools following professional development courses in companies or training centres; business experts giving lectures or training in higher education institutions, companies active in Corporate Social Responsibility developing volunteering schemes with associations and social enterprises, etc.).

A third important element of innovation and quality of mobility activities is that Erasmus+ participating organisations will have the possibility to organise mobility activities within a broader strategic framework and in the medium term. Through a single grant application, covering a period of up to two years, the coordinator of a mobility project will be able to organise several mobility activities, allowing many individuals to go abroad to different countries. As a consequence, under Erasmus+ the applicant organisations will be able to conceive their project in line with the needs of participants,

but also according to their internal plans for internationalisation, capacity building and modernisation.

5.2.3. Erasmus Mundus Joint Master Degrees

The Erasmus Mundus Joint Master Degrees is expected to contribute to the objectives of the Europe 2020 Strategy and of the E&T strategic framework 2020 (ET2020), including the corresponding benchmarks established in those policies. This programme is giving higher education – giving funding for MSc programmes – the funding for teacher and student mobility across European Universities and Institutions. There is a need for the involvement of European Universities, but within STAR and Radioecology, there are already several Universities involved.

Any future Erasmus Mundus Joint Master Degree (EMJMD) within the area of Radioecology/ Environmental Radioactivity could also draw important experience from the Master programme at Norwegian University of Life Science (NMBU) which has been running since it was established as an outcome of the EC EURAC project and started under the EC ENEN-II project.

More information on the actual criteria's for applying for an Erasmus Mundus Joint MSc is given in Annex 1.

An EMJMD is a high-level integrated international study programme of 60, 90 or 120 ECTS credits, delivered by an international consortium of Erasmus Mundus Action 2 Higher Education Institutions (HEI) from different countries and, where relevant, other educational and/or non-educational partners with specific expertise and interest in the study areas/professional domains covered by the joint programme. Their specificity lies in their high integration/"jointness" and the excellent academic content and methodology they offer. There is no limitation in terms of discipline. The list of joint programmes funded under the previous programme can be found on the Executive Agency website.

All participating HEIs established in a Programme Country must be Master degree-awarding institutions and the corresponding Master certificate-covering the entire study programme of the EMJMD -must be fully recognised by the competent national authorities in the countries where these HEIs are established.

The successful completion of the joint Master programme must lead to the award of either:

- a joint degree (i.e. one single diploma issued on behalf of at least two higher education institutions from different Programme Countries and fully recognised in these countries), or
- multiple degrees (i.e. at least two diplomas issued by two higher education institutions from different Programme Countries and fully recognized in these countries).

If national legislation allows, joint degrees are encouraged, as they represent a full integration of the learning and teaching process. Besides the degree awarding HEIs from Programme Countries, other partner HEIs from Partner Countries can be involved in the award of joint or multiple degrees.

The possibility to send in a common Erasmus Mundus application for the field of Radioecology/Environmental Radioactivity should be explored in the future, within European collaborative projects as COMET, OPERRA, CONCERT, etc.

5.2.4. Capacity building

Capacity Building Projects are transnational cooperation projects based on multilateral partnerships primarily between HEIs from Programme and eligible Partner Countries financed through the above mentioned instruments. They can also involve non-academic partners to strengthen the links with society and business and to reinforce the systemic impact of the projects. Through structured cooperation, exchange of experience and good practices and individuals' mobility,

Capacity Building Projects aim to:

- support the modernisation, accessibility and internationalisation of the higher education field in the eligible Partner Countries;
- support eligible Partner Countries to address the challenges facing their higher education institutions and systems, including those of quality, relevance, equity of access, planning, delivery, management, governance;
- contribute to cooperation between the EU and the eligible Partner Countries (and amongst the eligible Partner Countries);
- promote voluntary convergence with EU developments in higher education;
- promote people to people contacts, intercultural awareness and understanding.

These objectives are pursued in the eligible Partner Countries, through actions that:

- improve the quality of higher education and enhance its relevance for the labour market and society;
- improve the level of competences and skills in HEIs by developing new and innovative education programmes;
- enhance the management, governance and innovation capacities, as well as the internationalisation of HEIs;
- increase the capacities of national authorities to modernise their higher education systems, by supporting the definition, implementation and monitoring of reform policies
- foster regional integration and cooperation across different regions of the world through joint initiatives, sharing of good practices and cooperation.

Two categories of Capacity Building Projects are supported:

Joint Projects: aimed at producing outcomes that benefit principally and directly the organisations from eligible Partner Countries involved in the project. These projects will typically focus on 3 different types of activities:

- curriculum development;
- modernisation of governance, management and functioning of HEIs;
- strengthening of relations between HEIs and the wider economic and social environment.

Structural Projects: aimed at producing an impact on higher education systems and promoting reforms at national and/or regional level in the eligible Partner Countries. These projects will typically focus on 2 different categories of activities:

- modernisation of policies, governance and management of higher education systems;
- strengthening of relations between higher education systems.

5.3. *Integration and funding of education, training and mobility activities in other radiation protection platforms and organizations.*

5.3.1. Multidisciplinary European Low Dose Initiative (MELODI)

MELODI is a European Platform dedicated to low dose radiation risk research (http://www.melodi-online.eu/). It was founded in 2010 as a registered association. The purposes of MELODI are to propose R&T priorities for Europe in its field of competence (EUROPE 2020 Strategy); seek the views of stakeholders on the priorities for research, keep them informed on progress made, and contribute to the dissemination of knowledge; and interface with international partners like WHO and IAEA.

Since the first MELODI workshop in Stuttgart the European low dose risk research strategy has made significant progress. The DoReMi NoE, was set up in January 2010 and will finish in 2016. DoReMi is supported by a grant within the 7 FP of the EU (http://www.doremi-noe.net)

Within DoReMi, they aim to develop an integrated support system for E&T within the low-dose radiation risk research community as a whole. The DoReMi NoE has organised a successful series of short focused courses on essential topics, held by consortium member institutions, each presenting a topic within their own expertise. Because of the DoReMi sponsorship the courses are offered at no cost, making them very accessible to students. Initially the courses have been funded by a dedicated budget in DoReMi, but an essential part of the work is to establish a continuing basis of support that will last beyond the term of the project.

5.3.2. European Radiation Dosimetry Group (EURADOS)

EURADOS is registered in the German Register of Societies as a non-profit association for promoting research and development and European cooperation in the field of the dosimetry of ionizing radiation (http://www.eurados.org/). Its financial resources originate from sponsoring institutions, from voting members, from levies raised for activities organized by EURADOS (annual meetings, training courses and intercomparison exercises), and from projects funded by the European Communities.

EURADOS maintains a network which includes experts, reference and research laboratories, and dosimetry services. This enables appropriate specialist groups to be formed in a timely manner to solve problems or promote research identified within EURADOS or upon request from external bodies.

5.3.3. European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery (NERIS)

The mission of NERIS is to establish a forum for dialogue and methodological development between all European organisations and associations taking part in decision

making of protective actions in nuclear and radiological emergencies and recovery in Europe. Its financial resources originate from the fee paid by their members (http://www.eu-neris.net/).

NERIS organises both dissemination workshops and training courses, at least once a year, on subjects related with the response and recovery to a nuclear and radiological emergency. Most of the workshops and courses are free, but there is a limitation in the number of attendees.

5.3.4. The platform for European Education and training in Radiation Protection EUTERP

The EUTERP, originally an initiative of the European Commission, was transformed into a legal entity as a Foundation under Dutch law in June 2010 (http://www.euterp.eu/).

The objectives of the Foundation are:

- to encourage and support harmonization of E&T requirements for Radiation Protection Experts (RPEs), Radiation Protection Officers (RPOs) and radiation workers, facilitating the mobility of these professionals;
- to promote the integration of radiation protection E&T systems into general vocational training and education infrastructures; and
- to act as a central focus for the sharing of information on training events, standards, developments, and all other related information.

The EUTERP Foundation aims to facilitate information exchange between all stakeholders in E&T in radiation protection through their website (www.euterp.eu), the publication of newsletters and through the organization of workshops.

The National Contact Points play an important role in the EUTERP Foundation. They disseminate information at the national level and keep EUTERP and its Associates informed about national regulatory requirements, national certification schemes for RPEs, RPOs, workers, etc.

5.3.5. Society of Environmental Toxicology and Chemistry (SETAC)

The SETAC has a wide range of activities aimed at students and other training courses for a wider audience (http://www.setac.org/). Summer schools and winter schools aim to offer scientists and students training through the best up-to-date knowledge in a specific topic. They include time for teaching, exchanges, case-studies and knowledge assessment. They are organized for scientists of diverse origins and activities (students, scientists at universities, regulatory offices and private companies), who have the appropriate background education.

At SETAC conferences, a range of student/young scientist-oriented activities are held:

- prizes (e.g. Young Scientist Award),
- conference mentors,
- lunches with stakeholders,
- student party,

- student volunteers who help at the meetings get free registration to that meeting and the next one, free accommodation, free admission to the student party, and 1 year SETAC membership.

Training for professionals and students is also provided as half- and full-day short courses held in conjunction with the annual meeting (full day: 245€ / 110€ for SETAC member/SETAC student member, 175€ / 80€ for a half day).

SETAC funds a lot of their activities from membership fees. Membership costs 120€ / 40€ (full price/student), with a reduction for recent graduates and developing countries. They also raise funds from partnership: http://www.setac.org/?page=SEPartners. For agencies/government partners this is 2000€/y, for business 3500€/y, for academic 1000€. They also have commercial sponsors (chemical companies, biotech companies, consultancies) that sponsor particular things, especially at conferences.

5.3.6. CINCH-II/NucWik

Part of the CINCH and CINCH-II projects funded specific E&T courses within nuclear chemistry, but they are mostly putting their effort into the NucWik webpage. This NucWik page (https://nucwik.wikispaces.com/) is a site for teaching material for Nuclear and Radiochemistry. Everybody is welcome to use this wiki, but it is primarily aimed at teaching at Universities. At NucWik you will find ready made texts, explanations, illustrations, calculation exercises, laboratory exercises, etc. to help you in teaching Nuclear and Radiochemistry.

This Wiki is open access, but if you want to contribute you must register as a user. This site provides e-learning material that can be used for everyone giving courses in nuclear and radiochemistry

6. Strategic plan for a sustainable integrated education and training platform in Radioecology.

As is stated in the "Education and Training Strategic Research Agenda in Radioecology" (STAR Deliverable 2.5), scientific research in radioecology and application of that knowledge in the radiation protection of man and the environment requires scientists and workers with adequate competence and appropriate skills. Research-based E&T depends on access to relevant infrastructures and facilities.

The challenge for E&T in radioecology is to maintain and develop a skilled workforce in Europe and world-wide, through university candidates and professionals trained within radioecology.

The strategic vision is to secure a sustainable, integrated European E&T platform in radioecology that attracts top-level graduates and provides a workforce that has the necessary skills to meet future scientific, economic and societal needs within radioecology and other nuclear and environmental sciences.

To achieve the strategic vision, six action lines will need to be addressed:

1. Increasing student and teacher mobility requires sustainable funding mechanisms within radioecology. Actions such as travel grants for students and guest lecturer fees have a relatively low cost, but need to be maintainable. Inclusion of PhD, post doc or young researcher positions in EU funded projects should be encouraged.
2. Exploring joint EU MSc opportunities through the Erasmus Mundus programme and other activities under OPERRA and Horizon 2020. This would include mechanisms to increase the number of ECTS courses in radioecology that are given by European Universities as well as to stimulate integration within the ALLIANCE.
3. Fostering links with other E&T programmes in nuclear and environmental sciences (e.g., radiation protection, emergency management, radiochemistry, ecology, environmental chemistry) to maximize use of infrastructure and human resources by ensuring courses are compatible between different disciplines. Links with environmental sciences (e.g. via lectures on courses) should be made at all education levels, from schools to post graduate.
4. Providing joint courses for students and professionals with both ECTS (academic credits) and ECVET (vocational credits). This will ensure efficient use of resources and offer important networking opportunities for students, both across countries and disciplines, as well as with potential employees.
5. Increasing stakeholder and employer involvement in E&T through student placements, sponsored courses or university positions, and development of specialized intensive courses to meet stakeholder needs. For professional training courses, particular focus should be placed on access to state-of-the-art methods and models.
6. Development of distance learning courses where applicable (e.g., modelling, impact and risk assessment), to increase the recruitment of students.

Some initiatives for funding education, training and mobility in radioecology include:

- To make use of existing student exchange mechanisms (e.g. country-specific with Canada, or ERASMUS).
- Perform joint research project including those funded by programme (e.g. BIOPROTA) or industry.
- Harmonize the radioecology E&T activities with existing E&T initiatives, both in the EC and in other platforms (EURADOS, MELODI, NERIS) and in international organizations (such as IAEA and OECD-NEA).
- Persuade stakeholders (industry) that they need radioecology knowledge. Consider an EMpower or Nuclear First type of system.
- Strengthen links with IUR, because although it has limited funding, IUR has a wide membership and also wishes to promote radioecology E&T initiatives.
- Use distance learning to reduce costs, as well as streamed lectures via videoconference, VLEs etc.

The funding mechanisms described in section 5, should be used to support sustainability of education, training and mobility within radioecology. The ALLIANCE will play a key role in the sustainability of many of the resources developed during the STAR NoE.

7. Recommendation for the future

Recruitment is essential for the future of radioecology. It is important to attract young people, even undergraduates and school children, as research has shown that their interest in science should be encouraged at this stage. The education of teachers and inclusion of nuclear science teaching in schools is also important. Radioecology should also be promoted through a variety of courses at the BSc level – for example as lectures on other chemistry, environmental science or nuclear science courses.

To attract the young students it is also important to further develop and use the social media, e-learning possibilities, virtual laboratories etc. to reach teenagers and young students. During STAR the @STARedioecology Twitter page and the Radioecology/Environmental Radioactivity Facebook page have been set up. The challenge is to frequently update these pages and fill them with different aspects of radioecology. This should be of interest for all scientists within the field of radioecology – giving the opportunity to make the science available and attract people to the field at the same time.

There is also a need to better engage with industry and future employers. Employers should be encouraged to offer placements, joint research projects and summer jobs, as these are activities that attract students. Also the multi-disciplinary nature of radioecology is an aspect that could be made attractive to students – there is both demand and a variety of possible job opportunities available to the candidates.

As to the future of both the E&T platform and the MSc in Radioecology, the main challenge in maintaining such a joint MSc programme is sustainable funding. Both the EU and the stakeholders need to find a way to help students pay their student fees, keeping in mind the notorious heterogeneity between the different EU universities concerning these fees (for instance between Germany and the United Kingdom). Provisions should be carried out to cover the cost of staff and student movements.

Mutual acceptance of course modules utilized within radioecology, radiochemistry, radiobiology and radiation protection is needed. Hopefully this work can be taken further as part of the COMET and OPERRA projects. The E&T collaboration between universities and institutes should be confirmed by Memorandum of Understanding and possible Joint degrees if the Bologna Model is implemented. Exploring the ERASMUS+ and Erasmus Mundus joint degree possibilities is important to facilitate joint degrees.

There are several educational and training networks, and the radioecology community (through COMET and the ALLIANCE) needs to foster and strengthen existing links with them. Training in close connection to stakeholders, especially industry, will be important to secure that training is relevant.

The countries/organizations engaged in the radioecology E&T platform could contribute: providing students, teachers, work placements, research projects, collaboration on courses or course modules, educational material and logistical support for student exchange.

Potential funding opportunities from the ALLIANCE need to be discussed, as well as the coordination of the common research resources (platform, virtual laboratory etc.). It also

needs to be accepted by ALLIANCE partners that there is a need to provide in-kind support in the form of personnel to E&T and even the possibility to sponsor professors at the host universities. It is also important to further develop and strengthen the links with to DoReMi, NERIS and other E&T platforms in Europe and worldwide.

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