



EUROPEAN  
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# COMET

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## MILESTONE MS54

Field studies course on Natural radionuclides

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## 1 Introduction

The field training courses are part of WP5 *Knowledge Exchange*, Task 5.3 *Maintaining and enhancing competence*. The overarching objective of this work package is to enhance and maintain European capacity and skills in radioecology by establishing a dynamic interaction promoting effective collaboration between researchers, tool developers, regulators and industry. The main efforts taken on in the frame of task 5.3 are aimed at developing training packages to maintain and enhance professional competence. The field training courses play important role among other activities planned in the work package as they are an opportunity for trainees to take part in measurement campaigns and gather experience in developing sampling strategies and application of different measurement techniques.

Two field training courses were decided (MS53) at the two radioecological observatory sites established in the frame of STAR. These courses would make use of the wealth of expertise and local knowledge held by the Polish and Ukrainian partners were. Due to external circumstances (political situation in Ukraine) the order of organizing the planned training courses was changed and the training course in Poland was carried out first (MS 57), on the theme “NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM) IN THE ENVIRONMENT”

The preliminary course programme has been published via the Radioecology Exchange web site (<https://wiki.ceh.ac.uk/download/attachments/208437507/The%20field%20course%20on%20NORM%20program%20-%20final.pdf?api=v2>) and a flyer has been distributed among ALLIANCE members and presented during STAR final meeting in Aix-en-Provence, in June 2015 (ANNEX 1).

The course was organized by Silesian Centre for Environmental Radioactivity Central Mining Institute (GIG) and Norwegian University of Life Sciences (NMBU), Centre for Environmental Radioactivity (CERAD), in cooperation with Stockholm University (SU) and Norwegian Radiation Protection Authority (NRPA).

The training course took place at the Silesian Centre for Environmental Radioactivity, Central Mining Institute (GIG), Plac Gwarków 1, 40-166 Katowice, Upper Silesia, POLAND, 7<sup>th</sup> – 10<sup>th</sup> September 2015. The field exercises were carried out at sites contaminated by NORM due to former and current industrial coal mining activities in the Upper Silesian Coal Basin (USCB).

## 2 Course structure

The training course was focused on most aspects of environmental radiation impact and risks associated with enhanced natural radioactivity released from different NORM industries and accumulated in the environment. Key processes controlling the behaviour of naturally occurring radionuclides in different ecosystems were outlined in the light of recent radioecology research, including basic concepts, variables/parameters and kinetics needed for modelling purposes.

Application of appropriate methods for assessing the radiation impact and risk in the context of the complex suite of natural radionuclides were discussed and then practiced during the field exercises. Lectures and exercises covered the whole impact assessment process starting with sampling strategies and protocol preparation, sampling campaign, sample pre-treatment and preparation, the use of state-of-the-art measurement techniques and ending with the use of Environmental Risk

Assessment models (ERICA tool). Special attention was paid to a freshwater ecosystem contaminated by radium released with brines due to the activity of a coal mine.

The intensive (4 days) course included theory (lectures) and training in the lab (radiochemistry, gamma and liquid scintillation spectrometry) and in the field (TLD dosimetry, radon measurement and sampling). The two-day field exercises took place at two sites contaminated by NORM:

- The first was a 32 hectares natural lake where radium rich brines from a coal mine had been discharged since the beginning of the 1980s until 2002. This has resulted in a large amount of radium isotopes accumulating in bottom sediments. Currently the lake is filled with fresh water. The exercises carried out at this site were focused on contamination inventory, radionuclides migration and possible risk assessment.
- The second site is a lake with the same history, but that has subsequently undergone a process of technical land reclamation and is now dry. The exercises carried out at this site were focused on land reclamation effectiveness assessment based on in situ gamma spectrometry, dose rate measurement and mapping, radon in soil and radon exhalation measurement, radium and radium progeny migration to biota.

### Course programme

Monday

Time	Title/subject	Type	Lecturer
7:30 – 8:00	Arrival of course attendees and registration		
8:00 – 10:00	General information about NORM: 1. Source of NORM, NORM industry, 2. Differences between NORM and TENORM, 3. NORM vs. natural background, HBRA (high background radiation area) 4. NORM/TENORM examples 6. Environmental behaviour of NORM	Lecture	NMBU /GIG/ Lindis Skipperud Bogusław Michalik
10:15 – 10:15	Coffee break		
10:15 – 12:00	Main processes (physical, chemical, biological/ecological) ruling behaviour (migration in terrestrial and aquatic environment, atmosphere ) of natural radionuclides and metals in environment	Lecture	SU/ Clare Bradshaw
12:00 – 13:30	Radionuclides speciation, mobility and bioavailability. Implied methods of measurement /assessment	Lecture	NMBU/ Lindis Skipperud

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(MS57) –Polish field studies course

Dissemination level: NA

Date of issue of this report: 5/10/2015

13:30 – 14:00	Lunch break		
14:00 – 15:15	Features of sampling and sample preparation in the context of surveys purpose	Lecture	GIG/Bogusław Michalik
15:15 – 15:30	Coffee break		
15:30 – 17:00	Regulation context. An example on already developed and enforced national regulation (Norway)	Lecture	NRPA/ Jelena Mrdakovic Popic/Bogusław Michalik

#### Tuesday (field exercises)

Time	Title/subject	Type	Lecturer
8:00 – 9:00	Drive to the site		
9:00 – 13:00	Bottom sediments sampling (cores/profiles) and water sampling – water fractionation	Field exercise	GIG/NMBU/ Lindis Skipperud Michał Bonczyk
13:00 – 13:30	Lunch break		
13:30 – 15:30	1. Methodology & statistical rules a. soil sampling , sampling grid measure, primary/laboratory sample b. biota sampling 2. Records and documentation	Field exercise	SU/GIG/ Bogusław Michalik Clare Bradshaw
15:30 – 17:00	NORM contaminated sites identification – sampling of soil cores/profiles	Field exercise	GIG/ Bogusław Michalik
17:00 – 18:00	Return to the lab		

#### Wednesday (field exercises)

Time	Title/subject	Type	Lecturer
8:00 – 9:00	Drive to the site		
9:00 – 13:00	in situ gamma spectrometry and dose rate mapping ( based on portable dose meters and TLD)	Field exercise	GIG / Michał Bonczyk Krystian Skubacz
13:00 – 13:30	Lunch break		
13:30 – 16:00	radon in soil gas measurement and radon exhalation measurement	Field exercise	GIG/ Małgorzata Wysocka

16:00 – 17:00	Return to the lab		
19:00	Joint dinner		

Thursday (lecture & laboratory exercises)

Time	Title/subject	Type	Lecturer
8:00 – 9:00	Radium measurement – the first stage of radiochemical procedure	Laboratory exercise	GIG/ Izabela Chmielewska
9:00 – 10:00	NORM metrology rudiments (alpha and gamma spectrometry, liquid scintillation spectrometry (LSC), radiochemistry , mass spectroscopy, track and TL detectors)	Lecture/ laboratory exercise	GIG/ Bogusław Michalik Izabela Chmielewska Michał Bonczyk
10:00 – 11:00	Radium measurement – radiochemical procedure – continuation	Laboratory exercise	GIG/ Izabela Chmielewska
11:00 – 11:15	Coffee break		
11:15 – 12:30	High resolution gamma spectrometry – direct measurement of radium 226, correction for lead 210, disequilibrium effects	Lecture/ laboratory exercise	GIG/ Michał Bonczyk Bogusław Michalik
12:30 – 13:30	Biota samples preparation – plant/ invertebrates / vertebrates	Lecture/ laboratory exercise	GIG/ NMBU Izabela Chmielewska Lindis Skipperud
13:30 – 14:00	Lunch break		
14:00 – 15:00	Radium measurement by LSC	laboratory exercise	GIG/ Stanisław Chałupnik
15:00 – 15:45	Dose (external, internal) to biota/humans calculation/assessment (ERICA)	Lecture	NRPA Justin Brown
15:45 – 16:00	Coffee break		
16:00 – 17:00	cont. Dose (external, internal) to biota/humans calculation/assessment (ERICA)	Lecture	NRPA Justin Brown
17:00 – 17:15	Feedback and wrapping up		





Lectures



Bottom sediments



Bottom sediments sampling



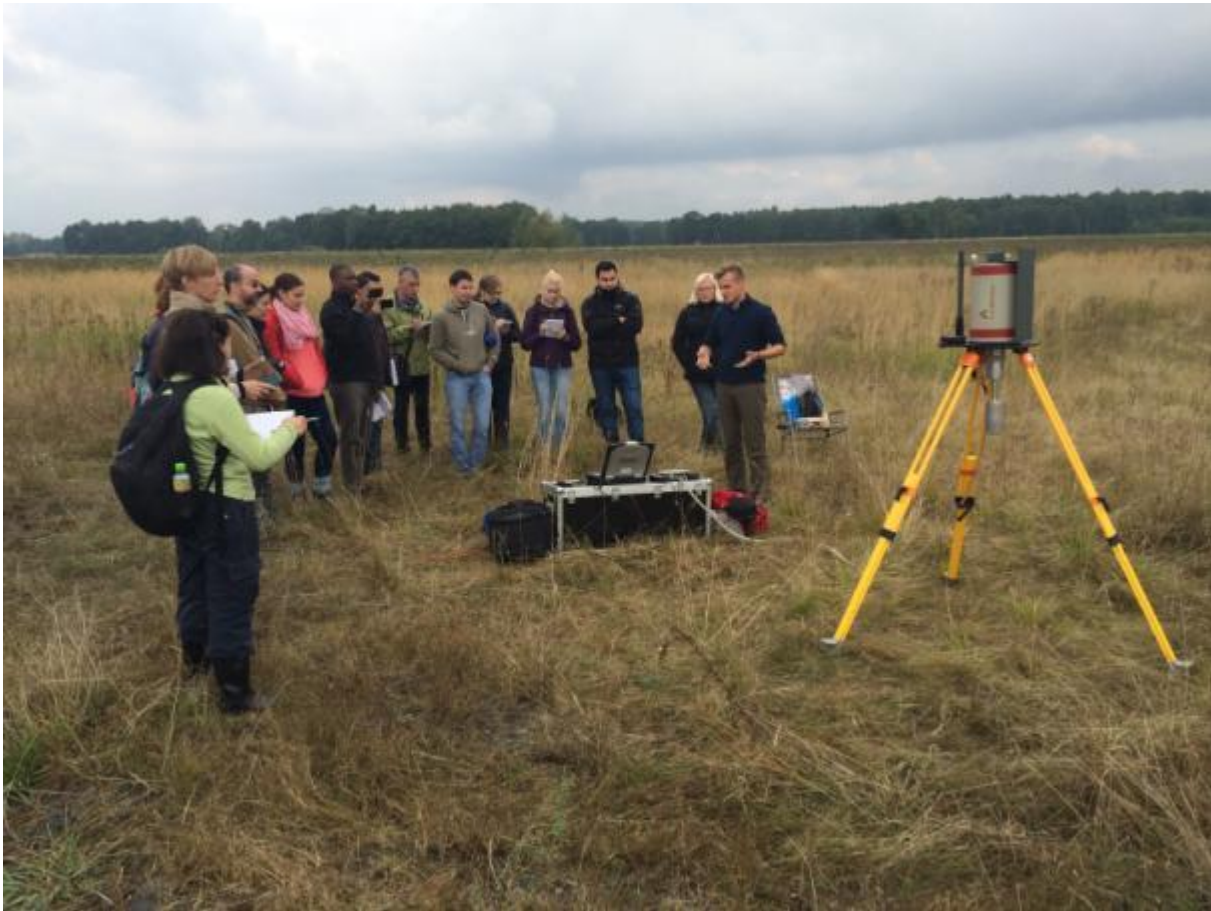


Water fractionation



Biota sampling





*In situ* gamma spectrometry



Radon exhalation



Radon concentration in soil



Soil sampling





Soil profile sampling



Gamma spectrometry



LSC





TLD

calibration

### 3 Participants

Due to the specific course structure the number of trainees was limited to 16 persons.

Eleven countries were represented, listed in order of number of attendees: Sweden (4), Belgium (2), UK (2), Angola, Estonia, Finland, Germany, Greece, Norway, Poland, and Spain. Taking into account occupation profile, seven participants represented universities, four authorities, three companies involved in radiation protection, one research institute and one national waste repository.



**Lecturers:**

**NRPA:**

Justin Brown (ERICA)

**Stockholm University :**

Clare Bradshaw (environment & biota)

**NMBU:**

Lindis Skipperud (NORM & water sampling)

**GIG:**

Bogusław Michalik (NORM)

Małgorzata Wysocka (radon)

Krzysztof Skubacz (TLD)

Michał Bonczyk (gamma spectrometry)

Iza Chmielewska (radiochemistry)

Stanisław Chałupnik (LSC)

At the end all participants received the course attendance certificate (Annex 2).

## 4 Course Material

Before the training course all registered participants were provided with the list of supporting official documents dealing with NORM issues and recommended articles published in scientific journals.

All lectures were given using MS PowerPoint presentations. For each exercise planned, as well laboratory as field an introductory presentation or short description were prepared in advance. All materials were printed out and provided to trainees as a handbook at the beginning of the course.

After the course, original PDF of all presentation were made available to course participants.

Final version of all lectures and exercises are currently available at Radioecology Exchange web site:  
<https://wiki.ceh.ac.uk/x/AAxDDw>

and is accessible from the link on this page:

<https://wiki.ceh.ac.uk/x/A4FsD>

## 5 Participant feedback

At the end of the course all participant were asked to fill a feedback questionnaire (Annex 3).

It consists of series of question concerning the quality of course content, practical aspects, exercises and facilities rated on a scale of 1 to 5. The simple statistics of obtained answers are presented in Annex 4. The questionnaire also included two open questions concerning course aspects that were rated the best and aspects that can be improved. The answers collected have been grouped according the aspects that they were dealing with and listed in the Annex 5.

## 6 Future plans

The course organiser registered far more applications than the number of participants planned. This means that the course met the expectations of the audience interested in NORM issues and it is worth repeating.

Experience gathered during this course organisation and information obtained from feedback questionnaire analysis are valuable and will be used when similar course in Ukraine are prepared.

# ANNEXES

## Annex 1: course flyer

<div></div> <div></div> <div><p>EU COMET course</p></div> <div><p><b>"COURSE ON NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM) IN THE ENVIRONMENT"</b></p></div> <div><p>at Silesian Centre for Environmental Radioactivity Central Mining Institute POLAND</p></div> <div><p>7<sup>th</sup> – 10<sup>th</sup> September 2014</p></div> <div><p>Organised by Silesian Centre for Environmental Radioactivity Central Mining Institute and Centre for Environmental Radioactivity (CERAD), Norwegian University of Life Sciences (NMBU)</p></div> <div><p>in cooperation with</p></div> <div><p>EU project: Coordination and implementation of a pan-European instrument for radioecology, COMET</p></div> <div><p>Hosted by Silesian Centre for Environmental Radioactivity Central Mining Institute Plac Gwarkow 1 40-166 Katowice, Upper Silesia, POLAND</p></div>	<div><p><b>Background</b></p></div> <div><p>In contrast to the monitoring and prevention of occupational radiation risk associated with enhanced natural radioactivity (NORM), relatively little attention has been paid to the environmental impact associated with residues containing enhanced activity concentration of naturally occurring radionuclides. Such materials are often deposited directly into environment usually close to the NORM production site (e.g., mining), a practice that is strictly forbidden in the management of other types of radioactive waste. In view of the new trends in radiation protection, to protect not only man but also the environment, there is a need to consider the occurrence of anthropogenic enhanced levels of natural radioactivity as a particular unique case representing environmental hazards.</p></div> <div><p>Residues containing high activity concentrations of natural radionuclides differ significantly from radioactive materials arising from that of the nuclear industry or from spent radioactive sources, in particular with respect to physical conditions (open diffuse sources within an operating site, no containment) as well as chemical composition. In addition NORM usually occurs in mixtures with a series of other stressors (e.g., heavy metals or organic chemicals), therefore the environmental impact will depend on the radiation risk combined with the risks associated with other pollutants. Thus, a multiple stressor scenario should be considered. As such and to date, there are no precise international regulations regarding NORM, and the non-nuclear industry is often unaware of potential environmental problems that may arise from enhanced levels of natural radioactivity.</p></div> <div><p><b>Scope and Objectives</b></p></div> <div><p>The present training course focuses on most aspects of environmental radiation impact and risks associated with enhanced natural radioactivity released from different sources and accumulated in the environment. Application of appropriate methods for assessing the radiation impact and risk in the context of the complex suite of natural radionuclides will be discussed, and the inconclusiveness of existing regulation will be explained. Key processes controlling the behavior of naturally occurring radionuclides in different ecosystems will be outlined, including basic concepts, variables/parameters and kinetics needed for modeling purposes. Sampling strategies and protocols will be presented, and training will include the use of state-of-the-art measurement techniques as well as the use of Environmental Risk Assessment models (ERICA tool).</p></div> <div><p>The intensive (4 days) course includes theory (lectures) and training in the lab (radiochemistry and radiation measurements) and at the field (dosimetry, sampling expedition). The field exercises will take place at sites contaminated by NORM.</p></div> <div><p><b>Learning Outcome:</b> After the course the students should have an overview over NORM sources, the main radioecology of NORM nuclides and be able to conduct measurements of some key NORM nuclides. In order to accomplish this the students need to acquire knowledge of:</p></div> <div><ul style="list-style-type: none"><li>• NORM sources and should understand the transport of NORM radionuclides in various ecosystems with special focus on physico-chemical forms (speciation) and their influence on mobility and biological uptake.</li><li>• Measurement of key NORM radionuclides</li><li>• Environmental impact and risk assessments i.e. competence that is needed within national preparedness associated with NORM contamination.</li><li>• Regulation of NORM</li><li>• Alternative countermeasures</li></ul></div> <div><p>2</p></div>
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### Course description

The course is given intensively over 4 days (September 7<sup>th</sup> - 10<sup>th</sup>) in Katowice, Upper Silesia, POLAND. Lectures, fieldwork and laboratory exercises are given integrated in these four days.

### Accommodation

Rooms will be arranged for at : in Hotel Olympia Spodek (about 65 Euro/night, ten minutes walk distance - <http://www.stylehotels.pl/en/olympia>) or in the hostel just next to the course venue for very economic price (15 Euro/night in a double room - <http://www.gwarek.katowice.pl>)

### Travel information :

The course venue is located 35 km from Katowice airport and 65 km from Kraków-Balice airport. The travel from Warsaw by a direct quick train takes 3 hours (four times per day)

Working language of the course will be English.

### Fee

There will be no registration fee. The course is covered by the EU COMET project. Participants are expected to cover their own travel and subsistence costs.

### Course Topics

LECTURES	LABORATORY EXERCISES, DEMONSTRATIONS, COMPUTER SESSIONS AND FIELD STUDIES
Key sources of NORM, and non-nuclear NORM industry	Soil, soil solution and biota sampling – methodology & statistical rules – records and documentation
Radiation protection and Regulation of NORM – and overlapping regulation dealing with non-radioactive pollutants	NORM contaminated sites identification - sampling of soil cores/profiles
Key physical/chemical processes affecting ecosystem transfer of naturally occurring radionuclides and metals in the environment – with sampling implications	Sampling of sediments and water - bottom sediments sampling (cores/profiles) and water fractionation at site/in lab
Sampling strategies and sample preparation protocols (soil cores/profiles, soil gas/soil solution, bottom sediments, water, vegetation/biota)	In situ gamma spectrometry and dose rate mapping
Radiochemical separations and measurements of NORM nuclides (alpha and gamma spectrometry, track and TL detectors, liquid scintillation spectrometry (LSC), mass spectrometry, radiochemistry)	Radon in soil gas measurement and radon exhalation measurement

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Radionuclides speciation, mobility and bioavailability - sequential extraction procedure and fractionation techniques	Radium measurement - extractions, radiochemical separations and LSC measurement
High resolution gamma spectrometry - direct measurement of radium 226, correction for lead 210, disequilibrium effects	High resolution gamma spectrometry - direct measurement of radium-226, correction for lead 210, disequilibrium effects
Doses (external, internal) from NORM to biota/humans: calculation/assessment (ERICA , RESRAD)	Dose (external, internal) to biota/humans calculation/assessment (ERICA , RESRAD)

### Target Audience

The target audience are NORM industry professionals and relevant authority representatives, as well as researchers or PhD students involved in radioecology who wants to develop their knowledge in NORM issues.

### Condition for participation

To apply for admission to join the courses through the EU COMET project please use the attached registration form or contact Bogusław Michalik (b.michalik@gig.eu) to obtain a registration form. Application deadline is June 26, 2015. There will be limitations to number of students – maximum 16 students.

### Date and Venue

The course will take place from 7 - 10 September 2014 at Silesian Centre for Environmental Radioactivity Central Mining Institute, Plac Gwarkow 1, 40-166 Katowice, Upper Silesia, POLAND.

### Important dates:

Pre-Registration/Intention to participate deadline:  
Request for accommodation:  
Training course:

June 26<sup>th</sup>, 2015  
September 1<sup>st</sup>, 2015  
October 7<sup>th</sup>-10<sup>th</sup>, 2015

### Contact & Information

Scientific co-ordination and registration	For accommodation and travel information
Bogusław Michalik e-mail : <a href="mailto:b.michalik@gig.eu">b.michalik@gig.eu</a> tel. +48 32 2592380	Anna Szymańska e-mail : <a href="mailto:a.szymanska@gig.eu">a.szymanska@gig.eu</a> tel. +48 32 2592295

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### Recommended background reading

#### IAEA publication

1. Radiation Protection and NORM Residue Management in the Production of Rare Earths from Thorium Containing Minerals Safety Reports Series 68
2. Radiation Protection and NORM Residue Management in the Titanium Dioxide and Related Industries Safety Reports Series 76
3. Radiation Protection and NORM Residue Management in the Zircon and Zirconia Industries Safety Reports Series 51
4. Assessing the Need for Radiation Protection Measures in Work Involving Minerals and Raw Materials Safety Reports Series 49
5. Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry Safety Reports Series 34
6. Radiation Protection against Radon in Workplaces other than Mines Safety Reports Series 33
7. Monitoring and Surveillance of Residues from the Mining and Milling of Uranium and Thorium Safety Reports Series 27
8. Naturally Occurring Radioactive Material (NORM V) Proceedings of an International Symposium held in Seville, 19-22 March 2007 Proceedings Series - International Atomic Energy Agency
9. Management of NORM Residues IAEA TECDOC 1712

#### Articles

1. Michalik B. NORM impacts on the environment: An approach to complete environmental risk assessment using the example of areas contaminated due to mining activity. Applied Radiation and Isotopes 2008;66:1661-5.
2. Michalik B. Is it necessary to raise awareness about technologically enhanced naturally occurring radioactive materials. Journal of Environmental Monitoring 2009;11:1825-33.
3. Michalik B, Brown J, Krajewski P. The fate and behaviour of enhanced natural radioactivity with respect to environmental protection. Environmental Impact Assessment Review 2013;38:163 - 71.
4. Mrdakovic Popic J, Bhatt CR, Salbu B, Skipperud L. Outdoor 220Rn, 222Rn and terrestrial gamma radiation levels: investigation study in the thorium rich Fen Complex, Norway. Journal of environmental monitoring : JEM 2012;14:193-201.
5. Popic J, Salbu B, Strand T, Skipperud L. Environmental impact assessment of radionuclide and metal contamination in the thorium (Th) rich Fen area, Norway. In: Strand P, Brown J, Jolle T, editors. International Conference on Radioecology & Environmental Radioactivity. Bergen, Norway: NRPA; 2008. p. 390.
6. Popic JM, Salbu B, Strand T, Skipperud L. Assessment of radionuclide and metal contamination in a thorium rich area in Norway. Journal of environmental monitoring : JEM 2011;13:1730-8.
7. Skipperud L, Jorgensen AG, Heier LS, Rosseland BO, Salbu B. Po-210 in fish from Taboshar uranium mining Pit Lake, Tajikistan. Journal of Environmental Radioactivity 2012.
8. Skipperud L, Stromman G, Yumusov M, Stegnar P, Uralbekov B, Tilboeov H, et al. Environmental Impact Assessment of radionuclide and metal contamination at the former U sites Taboshar and Digma, Tajikistan. Journal of Environmental Radioactivity 2012.

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9. Stromman G, Rosseland BO, Skipperud L, Heier LS, Burkharboev M, Uralbekov B, et al. U isotope ratio in water and fish from Pit Lakes in Kuryay, Kazakhstan and Taboshar, Tajikistan. Journal of Environmental Radioactivity 2012.
10. Lind OC, Stromman G, Rosseland BO, Stegnar P, Tolongutov B, Salbu B. Environmental Impact Assessment associated with the former uranium mining site at Kadi-Sai, Kyrgyzstan. Journal of Environmental Radioactivity 2012.
11. Salbu B, Burkharboev M, Shusikov I, Kayukov P, Uralbekov B, Stromman G, et al. Environmental Impact Assessment associated with the former uranium mining site at Kuryay, Kazakhstan. Journal of Environmental Radioactivity 2012.
12. Stegnar P, Yumusov M, Tilboeov H, Zjarjev G, Skipperud L, Salbu B. Gamma and Rn dose Assessment associated with former uranium mining sites in Tajikistan Journal of Environmental Radioactivity 2012.

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## Annex 2: Course certificate



We hereby certify that

**JAN KOWALSKI**

attended in a training course:

**"COURSE ON NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM)  
IN THE ENVIRONMENT"**

at

Silesian Centre for Environmental Radioactivity,  
Central Mining Institute, POLAND

7<sup>th</sup> – 10<sup>th</sup> September, 2015

Organised by: Silesian Centre for Environmental Radioactivity

and

Centre for Environmental Radioactivity Norwegian University of Life Sciences, Stockholm University &  
Norwegian Radiation Protection Authority

in cooperation with

**EU project: Coordination and implementation of a pan-European instrument for  
radioecology, COMET**

Course content

Lectures /12 hours	Field and laboratory exercises /15 & 5 hours
✓ Source of NORM, NORM industry,	✓ Sampling methodology & statistical rules, NORM contaminated sites identification ,
✓ NORM list and examples,	✓ Soil, water, bottom sediments & biota sampling,
✓ Environmental behaviour of NORM,	✓ In situ gamma spectrometry and dose rate mapping,
✓ Main processes ruling of natural radionuclides and metals behaviour in environment,	✓ Radon in soil gas and radon exhalation measurement,
✓ Radionuclides speciation, mobility and bioavailability,	✓ High resolution gamma spectrometry – direct measurement of radium 226, correction for lead 210 & disequilibrium effects,
✓ NORM metrology rudiments,	✓ Radium radiochemical separation & measurement by LSC.
✓ Features of sampling and sample preparation,	
✓ Dose to biota/humans calculation/assessment (ERICA)	
✓ Regulation context.	




Course leaders:

**Bogusław Michalik**      **Lindis Skipperud**      **Clare Bradshaw**      **Justin Brown**



Head of Silesian Centre  
for Environmental Radioactivity

### Annex 3: The feedback questionnaire structure

COURSE ON NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM) IN THE ENVIRONMENT  
Katowice, 7<sup>th</sup>-10<sup>th</sup> September 2015

### FEEDBACK QUESTIONNAIRE

For each question below, please circle the answer which most accurately reflects your view.

**Content**

1. How clear were the objectives of the course?	Unclear 1 2 3 4 5 Very clear
2. How well structured was the course? (Was the introduction clear, did it progress logically)	Poorly 1 2 3 4 5 Well
3. How relevant was the course content?	Irrelevant 1 2 3 4 5 Relevant
4. How did you find the amount of material covered?	Too much 1 2 3 4 5 To little
5. How difficult did you find the material covered?	Difficult 1 2 3 4 5 Easy
6. How interesting did you find the material covered?	Not interesting 1 2 3 4 5 Interesting

**Practical**

7. How did you find the practical exercises?	Not interesting 1 2 3 4 5 Interesting
8. Did the exercises help you understand the material presented in the course?	No 1 2 3 4 5 Yes
9. Were you given sufficient guidance to enable you to carry out the exercises?	No 1 2 3 4 5 Yes
10. Was the balance between presentations and practical exercises correct?	No 1 2 3 4 5 Yes

**Facilities**

11. How suitable were the field exercise areas?	Not suitable 1 2 3 4 5 Suitable
12. How suitable were the laboratory facilities?	Not suitable 1 2 3 4 5 Suitable
13. How suitable was the lecture room?	Not suitable 1 2 3 4 5 Suitable
14. Were meals provided acceptable?	No 1 2 3 4 5 Yes

**Summary**

15. Please name up to three:	
best things on the course:	things that could be improved (and how):
I.	I.
II.	II.
III.	III.
16. Did the course fulfil your expectations? <i>If not, please state why in the back side</i>	
No 1 2 3 4 5 Yes	

If you would like to make any additional comments, please use the back side  
Leave your name if you require any feedback.

**Thank you**

NORM course Feedback Questionnaire

## Annex 4: The feedback questionnaire analysis

### I. Basic statistics

Participant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVERAGE
Question	CONTENT																
1. How clear were the objectives of the course?	4	4	5	4	5	5	4	5	5	5	4	2	4	5	4	5	4,38
2. How well structured was the course?	4	5	3	4	4	5	4	5	4	5	5	4	4	5	5	4	4,38
3. How relevant was the course content?	5	5	4	5	4	5	5	5	4	5	4	4	5	4	4	4	4,50
4. How did you find the amount of material covered?	3	2	3	3	3	3	2	3	5	5	3	5	5	4	4	3	3,47
5. How difficult did you find the material covered?	4	4	4	5	3	3	3	5	3	4	4	4	4	4	3	4	3,81
6. How interesting did you find the material covered?	4	5	4	4	4	5	5	5	5	5	4	4	5	4	4	4	4,44
PRACTICAL																	
7. How did you find the practical exercises?	4	4	5	5	5	5	4	5	4	5	5	4	4	5	5	5	4,63
8. Did the exercises help you understand the material presented in the course?	4	5	3	5	5	5	5	5	5	5	4	4	5	5	4	5	4,63
9. Were you given sufficient guidance to enable you to carry out the exercises?	4	5	5	5	4	5	5	5	5	5	4	3	3	3	5	4	4,38
10. Was the balance between presentations and practical exercises correct?	4	5	5	4	4	5	5	5	4	5	5	3	5	5	5	4	4,56
FACILITIES																	
11. How suitable were the field exercise areas?	5	5	5	5	4	5	5	5	4	5	4	4	4	5	5	4	4,67
12. How suitable were the laboratory facilities?	4	5	5	5	3	5	5	5	5	5	4	4	5	5	5	5	4,73
13. How suitable was the lecture room?	5	5	3	5	4	5	5	5	5	5	2	4	4	5	5	4	4,47
14. Were meals provided acceptable?	5	5	4	5	5	5	5	5	5	4	5	4	5	5	5	4	4,80
SUMMARY																	
15. Did the course fulfil your expectations?	4	4	5	4	4	5	5	5	5	5	4	3	4	4	4	4	4,31

## Annex 5: The feedback questionnaire analysis

### II. Open questions answers: (directly cited after course attendees)

#### 1. Best things on the course:

##### a) Issues concerning practical part of the course:

- field demonstration
- good overview on NORM
- we had the opportunity to visit the installations, laboratories and saw the equipment
- practical part with field exercises
- direct interactions with NORM areas
- the two field exercise days
- introduction to the different laboratory measurement equipment
- in situ gamma radiation measurements and dose rate mapping

[COMET]

24/26

(MS57) –Polish field studies course

Dissemination level: NA

Date of issue of this report: 5/10/2015



- in situ gamma spectrometry
- radium measurements, radiochemistry separation
- laboratory visit was the most interesting and beneficial
- field exercises
- field work
- radiochemistry
- chance to see methodology of another institute

**b) Issues concerning organisation of the course:**

- kind organisation of the course
- multidisciplinary courses
- organised program
- well organised and presented, a great experience
- combining theoretical part with practical one was very appropriate
- the number of participants was suitable to have a more personal approach
- the general organizing was smooth and supportable
- good mix between lectures and exercises (although first day was a little too long for all lectures)
- the complex nature of the course: lectures, field exercises, lab exercises
- easy to follow every lecture because we had presentations in advance
- that we got all into in a „book”
- course materials

**c) Issues concerning lectures:**

- teachers explain lessons very clear
- lessons were very specific
- multidisciplinary and complimentary lectures
- excellent lectures, really interesting
- it covered most of the topics in NORM issues
- very well explained
- lectures
- different lectures knowing different areas
- the content
- wide content, progressively difficult lectures (from basic to complex)

**d) Issues concerning participants:**

- internationality of participants
- Paweł and Krystian (comment: *gamma dose rate mapping exercise leaders*) were brilliant, you could tell that they are really good at their job and passionate about it
- opportunity to meet others interested in NORM + experiences
- people working in GIG

**2. Things that could be improved (and how):**

**a) Issues concerning practical part of the course:**

- more fieldwork with hands on experience
- maybe more possibilities for taking samples oneself (find out how to handle new instruments and machines)

- individually or in small groups actual participation in the field exercise areas (more active interactions with the participants)
- touch the equipment and get more familiar with different software
- I would have appreciate to do the exercises in small groups
- more practical work with radiochemistry

**b) Issues concerning organisation of the course:**

- better time balance over the whole course in terms of information given (3rd day short/1st and last day)
- the lectures were to dense in short time, more time for lectures
- a full week with additional lectures would be even better
- it would be beneficial to have more lectures on the experience from other EU countries on NORM waste management
- first day a little to long for all lectures
- would have been useful to have list of attendees + their organisations etc at start of course
- i know more people interested to attend this course, but only 16 attendee/participants, try to enlarge this number next time
- lecture hall: more ventilation, look straight ahead, not sit sideward

**c) Issues concerning lectures:**

- more fundamental and small introduction of nuclear physics and chemistry
- sum up of problems regarding NORM all over the world, worst and best cases of resolving the NORM problem (e.g. cooperation).
- during the last day things were little bit rushed, there was no time for longer discussion so an additional day or half a day would have been good
- more time for discussion, maybe the same content but 5 instead of 4 days
- regarding simulation packages, a practical session should also be included in future course
- breaks between the lectures, 45 minutes is the maximum time for concentration
- difficult to be concentrated for a full day of lectures (but it is difficult to avoid...)
- i would have liked to work with the ERICA program
- it would be better to have all presentations in the lecture room, it was hard to see screens and here outdoors
- less NORM theory
- more radiochemistry
- more ERICA
- more time for questions and for deeper discussion

**e) Issues concerning conference materials:**

- please print material larger (2 slides per page, no extra space for notes, just writing on slide)
- not all lecture slides were in the course notes

**e) Issues concerning food:**

- lunch was quite a lot and made me sleepy in the afternoon