
ENVIRONMENTAL RADIOACTIVITY

Annual Activity Report 2013

UNIT: Radiation Protection and Safety

TEAM

| Name | Category | R&D |
|----------------------------|-------------------------------|------|
| Maria José Madruga | Principal Researcher | 100% |
| Fernando P. Carvalho | Principal Researcher | 100% |
| José Alberto G. Corisco | Auxiliary Researcher | 100% |
| Mário Capucho dos Reis | Auxiliary Researcher | 25% |
| João Maria Oliveira | Graduated Technician | 100% |
| Maria Irene Lopes | Graduated Technician | 100% |
| Maria Margarida Malta | Graduated Technician | 100% |
| Anabela Figueiredo Mourato | Technician | 100% |
| Maria Albertina Libânio | Technician | 100% |
| Ana Rita Dias Gomes | Grantee GCT (FCT)/Grantee IST | 100% |
| Eva Andrade | Grantee GCT (FCT)/Grantee IST | 100% |

OBJECTIVES

The objectives of the Environmental Radioactivity Group (GRA) are:

- The development of research activities in the study of the biogeochemical cycles of natural and artificial radionuclides in the atmosphere (aerosols) aquatic and terrestrial environments under projects funded by FCT, EC, FP-7, QREN/IAPMEI, etc.;
- The implementation of the annual environmental radiological monitoring programmes (at National Level, the Source Related programme for the CTN *Campus* and the Specific programme for the Regions around Old Uranium Mining Sites) to fulfil the State's obligations (Decree-Law 138/2005, 17th August) and the EURATOM Treaty Article 35/36 requirements;
- To maintain the requirements of the Quality Management System (NP ISO/IEC 17025) implemented at the GRA laboratories including the accreditation of radioanalytical techniques by the Portuguese Accreditation Body (IPAC). The participation in international inter-comparison exercises in order to prove the quality of the results issued.
- The development and improvement of radioanalytical techniques;
- Provide technical services to private and public entities to fulfil State's obligations in the determinations of radioactivity levels in waters, foodstuff, indoor radon, etc.
- To maintain operational the radionuclide particulate station RN53, installed at São Miguel island, Azores, belonging to the International Monitoring System (IMS) network for the verification of the Comprehensive nuclear-Test Ban Treaty (CTBT)
- Participation in national and international technical and scientific committees (IAEA, IAEA-ALMERA, EC, ISO, CTBT, etc) to fulfil legal's obligations or as advisors;
- Provide high education and training in environmental radioactivity and radiological protection;
- Dissemination of the GRA activities with the preparation of papers for presentation in conferences, workshops, etc., for publication in peer-reviewed international scientific journals and elaboration of internal reports;

MAIN ACHIEVEMENTS

Research & development activities

DYNOZONE (FCT project) - A time series analysis of the natural atmospheric ⁷Be (cosmogenic radionuclide) and ²¹⁰Pb (radionuclide of terrestrial origin) was performed, focused mainly on the temporal evolution of ⁷Be due its great potential as natural tracer for tropospheric intrusion of air

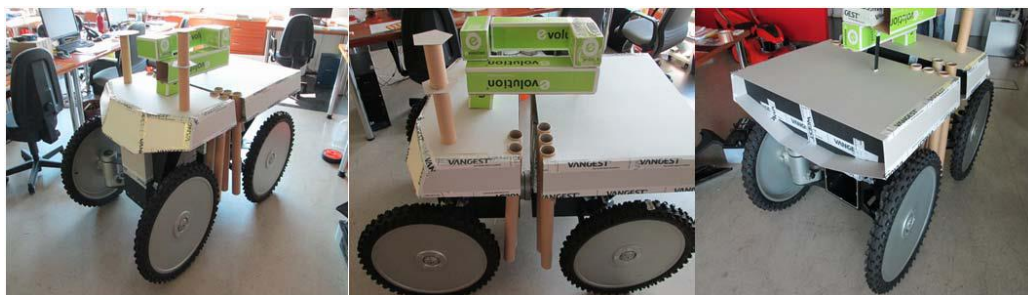
masses with stratospheric origin. By integrating ^7Be data, ozone air quality data and reanalysed meteorological fields, several events with high probability of stratospheric intrusions were identified. During 2013, the work regarding the analysis of the stratospheric tracer ^7Be was continued. Besides the data from Sacavém (based on weekly samples), also data from Oporto (48 hours frequency) and Ponta Delgada (daily samples) was used and correlated with other meteorological parameters and ozone data in order to enable detection of short duration and local scale events and confirm (or not) the contribution of stratospheric intrusions in high level ozone episodes at surface air.

ENGENUR - Implementation (3rd year) of the «ENGENUR» research project funded by the FCT, in collaboration with the University of Aveiro. Analyses of samples from biota exposed to uranium mine waste and search of correlation of toxic effects and exposure. Implementation of an experimental set up in the field near an old uranium mine to assess radionuclide transfer to agriculture products and animals.

PREPARE (FP7-Euratom) - The project aims to close gaps that have been identified in nuclear and radiological preparedness following the first evaluation of the Fukushima disaster. It addresses the call Fission-2010-3.3.1: Update of emergency management and rehabilitation strategies and expertise in Europe. The consortium intends to review existing operational procedures in dealing with long lasting releases, address the cross border problematic in monitoring and safety of goods and will further develop still missing functionalities in decision support systems. The 1st meeting of the WP3 (Contaminated Goods), to discuss the National Panels methodology, programme, coherence and follow-up, was held in May 2013 at CIEMAT, Madrid. Participants: M.J. Madruga, M. Reis. According to the WP6 (Information and Participation of the Public) deliverables, a Workshop on Managing Complexity in Nuclear Accidental Situations was organized at the CTN by the IST project team, in November 2013.

KADR Waste (follow up) - The investigation on the ^{137}Cs adsorption/desorption in *raña* (continental detrital sediments, constituted mainly by clay minerals) was continued in order to study the irreversibility of radiocaesium sorption in the natural clay-rich matrix and the influence of other ions competing (K^+ and Mg^{2+}) in the media.

ROBOSAMPLER (QREN/IAPMEI/PORLISBOA) - Joint project coordinated by the Portuguese private enterprise Introsys S.A. in a cooperation with institute Uninova and IST/CTN. The aim is to manufacture a robotized system comprised of a terrestrial 4 wheel robot and an autonomous aerial vehicle, devoted to sampling tasks in estuarine mudflats. Operational tests of the accomplished system will be made in the intertidal mudflats of Tejo estuary running from Samouco to Alcochete. Sampling processes will focus on bottom sediments cores, seaweeds and bivalves. During the first year IST/CTN personnel was devoted to field exercises with engineers from Introsys and Uninova, aiming to achieve a comprehensive picture of technical and functional requirements. First semester delivered documents comprised technical reports on Requirements and Sensor Module. Second semester was dedicated to field exercises with a terrestrial robotized vehicle prototype - Introbot™ - developed by Introsys and with a build from scratch sediment core collector, hand operated, used as an intermediate tool to gather information on the required force for collecting sediment samples, and also to refine the appropriated design of the device to be applied in the ROBOSAMPLER itself. It is expected that the robotized system will be supplied by the end of March 2014. Field tests and monitoring campaigns will extend to late summer. IST/CTN will process all sampled material for gamma spectrometry analysis and neutron activation analysis.



NATURAL RADIOACTIVITY IN BUILDING MATERIALS - A collaborative research with University of Extremadura (Cáceres, Spain) beginning in 2012 and is going on to determine the natural radionuclides concentrations and radon exhalation in building materials commonly used in Iberian Peninsula. To evaluate the radon exhalation from these materials two methods were used. In one of the methods (active technique) the radon exhalation rate was measured following the radon activity growth as a function of time using a continuous radon monitor, in the other one (passive technique) was determined through integrated measurements by using solid state nuclear track detectors (SSNTD).

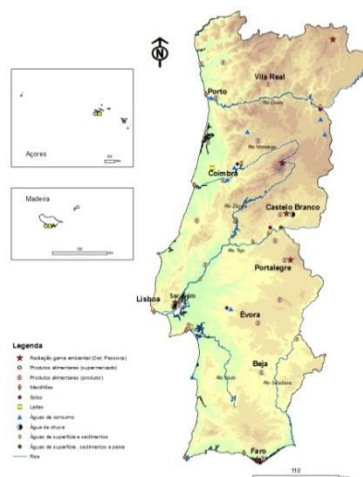
CAPTAR - Participation in the education web based project CAPTAR (Web site: captar.web.ua.pt) in the field of environmental sciences. Project coordinated by the University of Aveiro, funded by the Gulbenkian Foundation.

Legal obligations activities

The Radiological Environmental Monitoring Programmes were performed in collaboration with the Measurement Laboratories (LM). The radiological environmental survey has as main objectives to quantify the artificial and natural radionuclide levels in the environment (aquatic, terrestrial and atmospheric) considered as direct pathways of contamination to man and to evaluate the external radiation levels in order to assess the potential exposure of the Portuguese population.

During 2013, about 530 samples (aerosols, rainwater, surface water, drinking water, sediments, fish, mixed diet, complete meals, milk, soils, etc.) were collected and a total of about 1700 analyses were performed for the determination of artificial and natural radionuclides, using gamma and alpha spectrometry, alpha/beta measurements and liquid scintillation technique. The results show that Portuguese population was not exposed to radioactive contamination levels higher than the radioactive background. Consequently, there is no need to adopt any measures for radiological protection of the population. All the data are

published in Internal Reports available on the IST/ITN website (<http://www.itn.pt>) and entered on the European Radioactivity Environmental Monitoring Database (REM) located at the EU Joint Research Centre, ISPRA (Italy). The implementation of these programmes required a proportion of time spent by the GRA human resources of about 75%.



Quality Management System according to NP ISO/IEC 17025

In January 2013, the external audit monitoring to the accredited radioanalytical techniques was performed by the Portuguese Accreditation Body (IPAC). The accreditation by IPAC of two more radioanalytical techniques (gross alpha and gross beta in waters by gas flow proportional counter) was achieved during 2013. In September 2013, an internal audit was carried out by independent auditors. During 2013, a continuous effort was devoted by the personnel to maintain and improve the quality system implemented at the GRA laboratories. The Group participated in collaboration with the Measurement Laboratories in international inter-comparison exercises for the radioanalytical techniques. The results published in 2013 were in good agreement/compatible with the reference values. In order to increase the Environmental Radioactivity Group and the Measurements Laboratories capabilities the technique for the determination of ^{222}Rn in waters by LSC was also improved. In this framework two papers were presented at the *International Conference Advances in Liquid Scintillation Spectrometry, LSC2013*, Barcelona, Spain, March 18-22 (2013).

Technical services

During 2013, a total of about 150 analyses were performed for the determination of gross alpha, gross beta, tritium and Total Indicative Dose in drinking waters (Decree-Law 306/2007), ^{222}Rn in waters and ^{90}Sr in foodstuff samples.

Following the National System of Building Energetic Certification for the Indoor Air Quality (Decree-Law 118/2013, Ordinance nº353A/2013 e NT-SCE-02) measurements of indoor radon were requested. Besides, since November 2003 a collaborative Protocol was established between UPSR and DECO to answer the associate's indoor radon requests. In 2013, about 490 measurements were carried out.

Other technical/scientific activities

GRA members were involved in scientific conference organizations, in international technical and scientific committees and working groups from IAEA, EC, ISO and CTBT and in high education and training activities in environmental radioactivity and radiological protection.

RELEVANT PAPERS

- A.C. Carvalho, M. Reis, L. Silva, M.J. Madruga, A decade of ⁷Be and ²¹⁰Pb activity in surface aerosols measured over the Western Iberian Peninsula, *Atmospheric Environment*, 67, 193-202 (2013), doi.org/10.1016/j.atmosenv.2012.10.060.
- F. P. Carvalho and A. Fajgelj, Radioactivity in Drinking Water: Routine Monitoring and Emergency Response. *Water Air Soil Pollution* 224: 1597 (2013), DOI 10.1007/s11270-013-1597-y.
- F. P. Carvalho and R. Edge, Uranium mining and milling: the need for reference materials in environmental radioactivity monitoring programmes. *International Journal of Environmental Studies* 70 (4): 603-610 (2013), DOI: 10.1080/00207233.2013.798492.
- F. P. Carvalho, J. M. Oliveira, L. Silva, M. Malta, Radioactivity of anthropogenic origin in the Tejo Estuary and need for improved waste management and environmental monitoring. *International Journal of Environmental Studies* 70 (6): 952-963 (2013), DOI: 10.1080/00207233.2013.845714.
- M.J. Madruga, F.P. Carvalho, M. Reis, J. Alves, J.A. Corisco, I. Lopes, J. Abrantes, J.M. Oliveira, L. Silva, L. Portugal, M. Malta, Y. Romanets, A. Libânio, A. Mourato, G. Silva, A. Batista, A.R. Gomes, E. Andrade, G. Carvalhal, J. Melo, M. Pereira (2013). Programas de Monitorização Radiológica Ambiental (Ano 2011). Internal Report LPSR, Série A, nº39/13, ISBN 978-989-96542-7-3, Depósito Legal 194022/03, pp. 137.

FUNDS

| Project/Service | Reference | Timeframe | 2013 |
|--|--------------------------------|-----------|---------|
| DYNOZONE- <i>Total column and surface ozone variability over the Iberian Peninsula: Dynamical and chemical atmospheric factors</i> | FCT PTDC/CTE - ATM/105507/2008 | 2011-2013 | 5000 € |
| ENGENUR- <i>Definition of new ENdpoints to assess GENtoxic effects resulting from environmental exposures to URanium, Uranium daughters and ionizing radiation in bioindicator species</i> | FCT PTDC/AAC-AMB/114057/2009 | 2010-2013 | 19000 € |
| ROBOSAMPLER- <i>Development of a Terrestrial Robotic System as a Tool for Radiological and Heavy Metal Monitoring in Estuarine Environments</i> funding by QREN/IAPMEI (PORLisboa) | Lisboa-01-0202-FEDER-24961 | 2013-2014 | 9800 € |
| Radiological risk of phosphogypsum. Contract with BAÍA do TEJO | Contract 2013 | 2013-2014 | 31000 € |
| Radionuclides emission by waste incineration: Contract with VALORSUL | Contract 2013 | 2013-2014 | 5000 € |
| Comprehensive Nuclear-Test Ban Treaty Organization “ <i>Testing and Evaluation and Post-Certification Activities</i> ” for the RN53 radionuclide particulate station | Contract nº. 2008-0065 | 2013 | 30000 € |
| Analyses of radioactivity in waters | Technical Services | 2013 | 13700 € |

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| Analyses of radioactivity in foodstuff | Technical Services | 2013 | 5000 € |
| Indoor radon measurements | Technical Services | 2013 | 30000 € |

INTERNATIONALIZATION

CTBTO Contract for the management of the RN53 radionuclide particulate station

The radionuclide particulate station RN53, installed at São Miguel island, Azores, belongs to the International Monitoring System (IMS) network for the verification of the Comprehensive nuclear-Test Ban Treaty (CTBT), which was signed and ratified by the Portuguese state. The station was already certified and is managed by the IST/ITN under the Contract n° 2008-0065 “*Testing and Evaluation and Post-Certification Activities*”. On 2013, CTBTO organized a *Technical Training Course for Radionuclide Station Operators using Cinderella Equipment*, 5-9 August, Reykjavik, Iceland. RN53 Participant: C. Ramalho (local station operator).

TEAM RESEARCHERS

NAME: Maria José Bação Madruga

CATEGORY: Principal Researcher

IST-ID: 5350

ACTIVITIES

| N° | Activity Description | R&D (%) |
|-------|---|---------|
| 1 | Research activity: <i>Radiocaesium adsorption/desorption on geomaterials from “Raña” deposits originated from the NE Portugal Mainland</i> , following the <i>KADRWaste – PTDC/CTE-GEX/82678/2006</i> . | 10 |
| 2 | DYNOZONE- <i>Total column and surface ozone variability over the Iberian Peninsula: Dynamical and chemical atmospheric factors</i> . Contract <i>PTDC/CTE -ATM/105507/2008</i> . | 5 |
| 3 | PREPARE- <i>Innovative integrative tools and platforms to be prepared for radiological emergencies and post-accident response in Europe (FP7-Fission 2012-3.3.1)</i> . | 10 |
| 4 | Responsible by the Radiological Environmental Monitoring Programme at National Level | 15 |
| 5 | Head of the Environmental Radioactivity Group (GRA) | 50 |
| 6 | Supervisor of Master thesis | 5 |
| 7 | Technical/scientific activities | 5 |
| Total | | 100 |

WORK SUMMARY

| N° | Work Summary and Main Achievements |
|----|--|
| 1 | Continental detrital sediments known as <i>raña</i> , mainly constituted by clay minerals such as smectite, kaolinite, and illite, originated from the NE Portugal seepage deposits, have been studied in terms of their performance as liner/backfill/buffers for low and intermediate radioactive level wastes (LILW) repositories. Adsorption of radionuclides on buffer and backfill materials is an important factor retarding the release and dispersion of radionuclides from the repository into the environment which can be described by their distribution coefficients (K_d). The studies performed have shown that K_d and radiocaesium adsorbed fraction values for <i>raña</i> decrease with increasing caesium concentrations. The highest values found for caesium at trace and low concentrations seem related to the stronger affinity of radiocaesium for the frayed edge sites (FES) of the clay fraction from <i>raña</i> . Studies were |

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| | <p>also carried out to evaluate the influence of other ions competing (K^+ and Mg^{2+}) in the media. The fraction of radiocaesium adsorbed at the highest caesium concentrations is independent of K^+ and Mg^{2+} ions. This may be due to an oversaturation of the adsorption capacity of mineral substrates forming the clay-rich matrix used. The irreversibility of radiocaesium sorption in the natural clay-rich matrix is demonstrated by the higher desorption K_d and the lower radiocaesium desorbed fraction values in comparison with adsorption data. Comparing the radiocaesium adsorption/desorption in presence of K^+ and Mg^{2+}, total reversibility is almost achieved with Mg^{2+}, mainly for the higher concentration.</p> |
| 2 | <p>A time series analysis of the natural atmospheric 7Be (cosmogenic radionuclide) and ^{210}Pb (radionuclide of terrestrial origin) was performed, focused mainly on the temporal evolution of 7Be due its great potential as natural tracer for tropospheric intrusion of air masses with stratospheric origin. By integrating 7Be data, ozone air quality data and reanalysed meteorological fields, several events with high probability of stratospheric intrusions were identified. During 2013, the work regarding the analysis of the stratospheric tracer 7Be was continued. Besides the data from Sacavém (based on weekly samples), also data from Oporto (48 hours frequency) and Ponta Delgada (daily samples) was used and correlated with other meteorological parameters and ozone data in order to enable detection of short duration and local scale events and confirm (or not) the contribution of stratospheric intrusions in high level ozone episodes at surface air.</p> |
| 3 | <p>In project PREPARE, IST is participating in 2 Work Packages: WP3 and WP6. The objective of WP3 is to contribute to the development of strategies, guidance and tools for the management of the contaminated products, taking into account the views of producers, processing and retail industries and consumers. In this sense national stakeholder's panels methodology were established, presented and discussed between the participating countries in the WP3 (Consumer Goods) meeting held in Madrid in May 2013. In Portugal, the 2 panels organized by IST one dedicated to foodstuffs/feedstuffs and another one to consumer goods are planned for the beginning of 2014 and 2015 respectively. The overall objective of the WP6 is to investigate the conditions and means for pertinent, reliable and trustworthy information to be made available to the public in due time and according to its needs in the course of nuclear emergency and post-emergency contexts. This WP will notably address the complex and dynamic dimensions of information flows in the context of nuclear emergencies. In 28-29th November 2013 a WP6 Workshop (Managing Complexity in Nuclear Accidental Situations) organized by IST was held at CTN where these issues were presented and discussed.</p> |
| 4 | <p>The Radiological Environmental Monitoring Programme at a National Level was established by law in 2005 (Decree-Law 138/2005, 17th August) and is performed yearly according to the EURATOM Treaty (Article 35) recommendations. Upon the merging of ITN in IST, its execution was formally and legally transferred to IST. The objective of the programme is to determine the radioactivity levels in environmental and foodstuff samples, collected along the country, considered as direct pathways of contamination to man and to assess the potential exposure of the Portuguese population. During 2013 about 300 samples (aerosols, rainwater, surface water, drinking water, sediments, fish, mixed diet, complete meals, milk, soils, etc.) were collected accordingly to international sampling procedures and a total of about 800 analyses were performed for the determination of artificial and natural radionuclides, using gamma and alpha spectrometry, alpha/beta measurements and liquid scintillation technique. The results show that the Portuguese population was not exposed to radioactive contamination levels higher than the radioactive background. Therefore, there is no need to adopt any measures for radiological protection of the population. All the data are published in Internal Reports made available in the IST/CTN website (http://www.itn.pt) and included in the European Radioactivity Environmental Monitoring Database (REM) located at the EU Joint Research Centre, ISPRA (Italy).</p> |
| 5 | <p>Management of the GRA activities, including human resources, goods, services and infrastructures. Coordination of: Quality Assurance System activities applied to the radioanalytical techniques implemented at the GRA in compliance with ISO/IEC 17025; development of new radioanalytical techniques; technical services provided by GRA under contract with private entities or governmental organizations; international inter-comparison exercises organized by the IAEA, EC, CSN. Participation in: coordination and accreditation</p> |

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| | group meetings conveyed by the UPSR coordinator; elaboration of internal documents issued by the UPSR coordinator; internal and external audits performed to the accredited radioanalytical techniques. |
| 6 | Supervision of M. Sc. thesis “ <i>Radionuclidos antropogénicos (¹³⁷Cs) em sistemas lagunares e estuarinos de Portugal: implicações ambientais</i> ” by Joel Costa Esteves. |
| 7 | Provide advices in environmental radioactivity and on the development of new techniques applied to the water quality to the following international groups: <ul style="list-style-type: none"> - Portugal representative of the Group of Experts <i>under Articles 35 and 36 of the EURATOM Treaty (EC)</i> - Portugal representative of the Group of Experts <i>ISO/TC 147/SC3 Water quality-Radiological methods</i> Participation on the CPEAMB (<i>Comissão de Planeamento de Emergência do Ambiente</i>) meetings, whenever requested. Reviewer of papers for: <i>Applied Radiation and Isotopes</i> and <i>Journal of Environmental Radioactivity</i> . |

PUBLICATIONS

- A.C. Carvalho, M. Reis, L. Silva, M.J. Madruga, A decade of ⁷Be and ²¹⁰Pb activity in surface aerosols measured over the Western Iberian Peninsula, *Atmospheric Environment*, 67, 193-202 (2013), doi.org/10.1016/j.atmosenv.2012.10.060.
- Madruga M.J., F.P. Carvalho, M. Reis, J. Alves, J.A. Corisco, I. Lopes, J. Abrantes, J.M. Oliveira, L. Silva, L. Portugal, M. Malta, Y. Romanets, A. Libânio, A. Mourato, G. Silva, A. Batista, A.R. Gomes, E. Andrade, G. Carvalhal, J. Melo, M. Pereira (2013). Programas de Monitorização Radiológica Ambiental (2011). Internal Report LPSR, Série A, nº39/13, ISBN 978-989-96542-7-3, Depósito Legal 194022/03, pp. 137.

COMMUNICATIONS

- *Qualidade da água para consumo humano: aspetos radiológicos*, M.J. Madruga, 3º Encontro Riscos, Ambiente e Qualidade do Ar, Fundação Calouste Gulbenkian, Lisbon, Portugal, January 31 (2013), Oral.
- *Quality control assurance of strontium-90 in foodstuffs by LSC*, I. Lopes, A. Mourato, J. Abrantes, G. Carvalhal, M.J. Madruga, M. Reis, *International Conference Advances in Liquid Scintillation Spectrometry, LSC2013, Barcelona, Spain, March 18-22 (2013)*, *Book of Abstracts* p. 122, Oral.
- *A couple of methods to calculate the activity of Rn-222 in water samples by means of LSC technique: preliminary comparative studies*, G. Carvalhal, J. Abrantes, I. Lopes, M.J. Madruga, M. Reis, *International Conference Advances in Liquid Scintillation Spectrometry, LSC2013, Barcelona, Spain, March 18-22 (2013)*, *Book of Abstracts* p. 76, Oral.
- *Problemática do radão (²²²Rn) e sua monitorização em ambientes atmosféricos interiores*, E. Andrade, M. Reis, M.J. Madruga, *Jornadas Científicas de Saúde Ambiental, 1th Annual Meeting of Coimbra Health School, April 13 (2013)*, *Book of Abstracts* p. 64, Oral.
- *Development of a couple of methods for measuring radon exhalation from building materials commonly used in the Iberian Peninsula*, C. Miró, E. Andrade, M. Reis, M.J. Madruga, *7th Conference on Protection against Radon at Home and at Work, Prague, Czech Republic, September 2-6 (2013)*, Oral.

EDUCATION

- Supervisor, M. Sc. Thesis, “*Radionuclidos antropogénicos (¹³⁷Cs) em sistemas lagunares e estuarinos de Portugal: implicações ambientais*”, by Joel Costa Esteves, Sciences Faculty of Oporto University, 12 September 2013.
- Panel member for M. Sc. Thesis of Joel Costa Esteves entitled “*Radionuclidos antropogénicos (¹³⁷Cs) em sistemas lagunares e estuarinos de Portugal: implicações ambientais*”, Sciences Faculty of Oporto University, 12 September 2013.

- Panel member for Doctoral Thesis of Montserrat Montaña Gurrera, entitled “*Optimization of alpha emitter’s determination in water. Behaviour of radionuclides in water treatment plants*”, Polytechnic University of Catalunya, Barcelona, Spain, 24 July 2013.
- Supervisor, summer training (22 July- 06 September 2013) on “*Técnicas radioanalíticas aplicadas à determinação dos níveis de radioatividade em amostras ambientais*” by Daniela Alves in the framework of the Master Degree in Environmental Engineering of Coimbra University.

PROJECTS

Submitted

- *Red de Laboratorios de Control de la Calidad Radiológica del Agua (RELACRA)*. Programa Ibero-americano de Ciência e Tecnologia para o Desenvolvimento (CYTED) Leading Institution: Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Madrid, Spain. IST Coordinator: M.J. Madruga (submitted).
- *Desarrollo de Métodos Innovadores de Determinación de la Radiactividad en Alimentos (DEMETRIA)*. Spanish National Research Programme. Leading Institution: Polytechnic University of Catalunya, Barcelona, Spain. IST Coordinator: M.J. Madruga (submitted).

CONTRACTS

| Contract Description | Client | Amount (€) |
|---|-----------------------------|------------|
| Analyses of radioactivity in waters | Private and public entities | 13456,20 |
| Analyses of radioactivity in foodstuffs | Private and public entities | 4329,60 |

CONFERENCE ORGANIZATION

- Participation on the 4th General Assembly of the NERIS Platform, Polytechnic University of Madrid, Spain, 21 May 2013.
- Participation on the 2nd meeting of the NERIS Working Group on contaminated Goods (ConGoo), CIEMAT, Madrid, Spain, 22 May 2013.
- Participation on the co-organization of the WP6, 2nd meeting (project PREPARE) and on the workshop in “Managing complexity in nuclear accidental situations, experts interacting with experts and society”, held at IST/CTN, 27-29 November 2013.

COLLABORATIONS

- Conrado Miró Rodriguez, Departamento de Física Aplicada, Universidad de Extremadura, Spain, collaboration regarding radon measurements.
- Iuliu Bobos, Faculdade de Ciências, Universidade do Porto, collaboration regarding radioactivity measurements in Portuguese estuarine and lagoon systems.
- Jasmina Kožar Logar, Department for Low and medium Energy Physics, Jožef Stefan Institute, Ljubljana, Slovenia, 22 April 2013

NAME: Fernando da Piedade Carvalho

CATEGORY: Principal Researcher

IST-ID: 25347

ACTIVITIES

| Nº | Activity Description | R&D |
|----|--|-----|
| 1 | Environmental radioactivity survey of old uranium mine regions | 50% |

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| | (IST/ITN; Art 35 Euratom) | |
| 2 | Research project «ENGENUR» funded by FCT, on environmental toxicology in uranium mining areas. | 20% |
| 3 | Training of Fellows and students. Invited lectures for post-graduation courses and dissemination of IST/ITN activities. Co supervision of a PhD Thesis. Participation in scientific committees of several international conferences. Scientific/technical missions at invitation by the IAEA | 10% |
| 4 | Implementation of contracts with industrial partners | 10% |
| 5 | Participation in international working groups for preparation of reference publications (IAEA Technical Report Series, one on radium and one on polonium) | 5% |
| 6 | Supervision and coordination of radiochemistry laboratories and alpha spectrometry. | 5% |
| Total | | 100 |

WORK SUMMARY

| Nº | Work Summary and Main Achievements |
|----|--|
| 1 | Annual activity to fulfill the State's obligations entrusted to IST / ITN, particularly under the EURATOM Treaty Article 35 and delivery of the Annual Environmental Radioactivity Monitoring Report. Conducting field missions in the regions of former uranium mines to determine external radiation and radon in the environment, sampling water, soil, aerosols, and agricultural and livestock products for determination of radionuclides, whose results are essential to assess the radiation exposure of the Portuguese population and part of the Annual Report on Environmental Radioactivity Monitoring Programme. Preparation of articles for publication in peer-reviewed international scientific journals and communications to conferences. |
| 2 | Implementation (3 rd year) of the «ENGENUR» research project funded by the FCT, in collaboration with the University of Aveiro. Analyses of samples from biota exposed to uranium mine waste and search of correlation of toxic effects and exposure. Implementation of an experimental set up in the field near an old uranium mine to assess radionuclide transfer to agriculture products and animals. |
| 3 | Supervision and training of students in analytical methods and environmental radioactivity (Three IAEA Fellows: two from Niger and one from Cameroon). Invited lectures on environmental radioactivity, uranium mining residues and radioactivity in water and food for post-graduation courses (Master) in FCT-Universidade Nova and FCT-Universidade de Lisboa, Advanced International Courses (KIT, Germany) and International Workshop for Central Asia Countries (IAEA, Vienna, Austria) Co-supervision of a PhD Thesis (University of Cadiz). Lectures on environmental radioactivity and monitoring of uranium regions, at Universities and Ministries in countries visited in IAEA missions (Algeria, Burkina Faso, Mauritania, Niger, and Zambia). Member of scientific and advisory committees of the organization of International Conferences. |
| 4 | Implementation of technical services contracts with industry in Portugal (phosphate waste and urban waste incineration). |
| 5 | Participation, following invitation by the IAEA in working groups to write two IAEA publications (books) for the Technical Report Series (Environmental Behaviour of Radium, completed; Environmental Behaviour of Polonium, on-going). |
| 6 | Supervision and coordination of analytical work in radiochemical analyses and alpha |

PUBLICATIONS

Peer-reviewed international publications

- Fernando P. Carvalho and A. Fajgelj (2013). Radioactivity in Drinking Water: Routine Monitoring and Emergency Response. *Water Air Soil Pollution* 224: 1597 (DOI 10.1007/s11270-013-1597-y)
- Fernando P. Carvalho and Russel Edge (2013). Uranium mining and milling: the need for reference materials in environmental radioactivity monitoring programmes. *International Journal of Environmental Studies* 70 (4): 603-610 (DOI: 10.1080/00207233.2013.798492).
- Fernando P. Carvalho, João M. Oliveira, Lídia Silva, Margarida Malta (2013). Radioactivity of anthropogenic origin in the Tejo Estuary and need for improved waste management and environmental monitoring. *International Journal of Environmental Studies* 70 (6): 952-963 (DOI: 10.1080/00207233.2013.845714).
- Fernando P. Carvalho (2013). Uranium series radionuclides in the water column of the Northeast Atlantic Ocean. In: *Isotopes in Hydrology, Marine Ecosystems, and Climate Change Studies Vol. II*, pp: 427-442. IAEA Pub 1580, International Atomic Energy Agency, Vienna.
- Fernando P. Carvalho, J. M. Oliveira, A. M. Soares (2013). ²¹⁰Pb-excess and sediment accumulation rates at the Iberian continental margin. In: *Isotopes in Hydrology, Marine Ecosystems, and Climate Change Studies, Vol. I*, pp: 451-462. IAEA Pub 1580, International Atomic Energy Agency, Vienna.
- Fernando P. Carvalho (2011). Past uranium mining in Portugal: legacy, environmental remediation and radioactivity monitoring. In: *The Uranium Mining Remediation Exchange Group (UMREG). Selected Papers 1995–2007*, pp. 145-155. IAEA, VIENNA, 2011, STI/PUB/1524 (ISBN 978–92–0–169310–5). International Atomic Energy Agency, Vienna. (Released in 2013)
- Margarida Malta, João M. Oliveira, Lídia Silva, Fernando P. Carvalho (2013). Radioactivity from Lisboa urban wastewater discharges in the Tejo River Estuary. *Journal of Integrated Coastal Zone Management* 13(4): 399-408 (DOI: 10.5894/rgci339).

National Publications

- Fernando P. Carvalho (2013). Monitorização da Radioatividade Ambiente. *INDÚSTRIA E AMBIENTE* 79 (MARÇO/ABRIL 2013): 14-18.
- Fernando P. Carvalho (2013): A cratera do Ngorongoro e a fauna africana. *Ecologi@ (Revista da Sociedade Portuguesa de Ecologia)* 6: 18-30 (2012) (ISSN: 1647-2829).
- F.P. Carvalho, J.M Oliveira, M. Malta (2013). Relatório Anual da Monitorização Radiológica dos Sítios das Antigas Minas de Urânio. Relatório Institucional IST/LPSR.

Extended Abstracts in Conference Proceedings

- Fernando P. Carvalho. Forest fires as a source to Polonium-210 and Lead-210 in the atmosphere. In: *Proceedings of the 2nd International Conference on Po and Radioactive Pb Isotopes (INCO-PoPb-2013)*, held in Mangalore, India, February 10-13, 2013, N. Karunakara and M. Baskaran (Ed.), pp. 19-22. University of Mangalore, India (INVITED TALK).
- Fernando P. Carvalho, João M. Oliveira, G. Alberto. Atmospheric depositions of ²¹⁰Pb and ²¹⁰Po in Lisbon, Portugal. In: *Proceedings of the 2nd International Conference on Po and Radioactive Pb Isotopes (INCO-PoPb-2013)*, held in Mangalore, February 10-13, 2013, N. Karunakara and M. Baskaran (Ed.) pp: 40-43. University of Mangalore, India.
- M. Zafrul Kabir, Fernando P. Carvalho, Farah Deeba, Sushmita Hossain, Massoud Fharim, Md Moniruzzaman, João M Oliveira, M. Malta. Polonium-210 and lead-210 in marine biota from a coastal region with high natural radioactivity. In: *Proceedings of the 2nd International Conference on Po and Radioactive Pb Isotopes (INCO-PoPb-2013)*, held in Mangalore, February 10-13, 2013, N. Karunakara and M. Baskaran (Ed.), pp: 248-250. University of Mangalore, India.
- F.P. Carvalho, M. Eugénia Melo, J.M. Oliveira, M. Malta, H. Vala, F. A. Esteves (2013). Acumulação de elementos radioactivos da família do urânio nos órgãos de ovelhas criadas na região centro do país. In: *Actas da 10ª Conferencia Nacional do Ambiente*, C. Borrego et al. (Ed.), pp: 951-952. Universidade de Aveiro, Portugal (ISBN: 978-989-98673-0-7).

- F.P. Carvalho, J.M. Oliveira, M. Malta (2013). Radionuclidos na cadeia alimentar terrestre na zona circundante de uma antiga mina de urânio (Mina do Boco, Gouveia). In: Actas da 10ª Conferencia Nacional do Ambiente, C. Borrego et al. (Ed.) pp: 953-954. Universidade de Aveiro, Portugal (ISBN: 978-989-98673-0-7).
- F.P. Carvalho, J.M. Oliveira, M. Malta (2013). Riscos ambientais na bacia hidrográfica do Rio Mondego e a qualidade radiológica da água. In: Actas da 10ª Conferencia Nacional do Ambiente, C. Borrego et al. (Ed.), pp: 955-956. Universidade de Aveiro, Portugal (ISBN: 978-989-98673-0-7).
- F.P. Carvalho, J.M. Oliveira, M. Malta (2013). Fogos florestais e libertação de radionuclidos para a atmosfera. In: Actas da 10ª Conferencia Nacional do Ambiente, C. Borrego et al., (Ed.), pp: 957-958. Universidade de Aveiro, Portugal (ISBN: 978-989-98673-0-7).
- M. Malta, J.M. Oliveira, L. Silva, P. Monteiro, M. Perdigão, F.P. Carvalho (2013). Radioactividade no Estuário do Tejo proveniente das descargas da Rede de Saneamento de Lisboa. In: Actas da 10ª Conferencia Nacional do Ambiente, C. Borrego et al. (Ed.), pp: 623-628. Universidade de Aveiro, Portugal (ISBN: 978-989-98673-0-7).
- J.M. Oliveira, M. Malta, F.P. Carvalho (2013). Monitorização da radioactividade ambiente na região das antigas minas de urânio. In: Actas da 10ª Conferencia Nacional do Ambiente, C. Borrego et al. (Ed.), pp: 41-44. Universidade de Aveiro, Portugal (ISBN: 978-989-98673-0-7).

COMMUNICATIONS

Abstracts of Communications to Conferences

- Fernando P. Carvalho, João M. Oliveira, M. Malta (2013). Radioactivity around old uranium mines and environmental remediation in Portugal. The 2nd International Conference on Environmental Pollution, Restoration and Management, held in Hanoi, March 4-8, 2013 (KEY NOTE PRESENTATION). Book of Abstracts, Ref 1205005.
- Dang Duc Nhan, Fernando P. Carvalho, Nguyen Thi Thu Ha, Nguyen Quang Long, Dao Dinh Thuan, Nguyen Ba Tien, and Heloísa Fonseca (2013). Radon (^{222}Rn) in houses in the coastal region of North Vietnam. The 2nd International Conference on Environmental Pollution, Restoration and Management, held in Hanoi, March 4-8, 2013. Book of abstracts, Ref 1301006.
- Fernando P. Carvalho, Dang Duc Nhan, João M. Oliveira, Nguyen Quang Long, Dao Dinh Thuan, and Margarida Malta (2013). Coal mining and radioactivity in the coastal area of Ha Long Bay in North Vietnam. The 2nd International Conference on Environmental Pollution, Restoration and Management, held in Hanoi, March 4-8, 2013. Book of Abstracts, Ref 1301005.
- Fernando P. Carvalho, João M. Oliveira, M. Malta (2013). Soil to plant transfer of uranium series radionuclides International Conference of the Society of Environmental Geochemistry and Health (SEGH 2013), held in Toulouse, France, from July 8th to 12th, 2013. Book of Abstracts.
- Fernando P. Carvalho, João M. Oliveira, M. Malta (2013). Radionuclides from uranium mining tailings in a mountain catchment area, Reboleiro, Portugal. International Conference of the Society of Environmental Geochemistry and Health (SEGH 2013), held in Toulouse, France, from July 8th to 12th, 2013. Book of Abstracts.
- F.P. Carvalho, J.M. Oliveira, M. Malta (2013). Environmental risk assessment in former uranium mining regions of Portugal. 5th International Congress on Energy and Environment Engineering and Management (CIEM), held at the Instituto Superior Técnico, Lisboa, 17-19 July. Book of Abstracts.
- F.P. Carvalho, J.M. Oliveira, M. Malta (2013). Biomass combustion and release of contaminants to the atmosphere. 5th International Congress on Energy and Environment Engineering and Management (CIEM), held at the Instituto Superior Técnico, Lisboa, 17-19 July. Book of Abstracts.
- Fernando P. Carvalho, João M. Oliveira, M. Malta (2013). Uranium mining residues and environmental and public health issues in Portugal. International Workshop on Uranium, Environment and Public Health, held at the Instituto Politécnico de Castelo Branco, Castelo Branco, 25 October 2013. Book of Abstracts.
- Fernando P. Carvalho, João M. Oliveira, M. Malta (2013). Radioactivity in the international Águeda River and other rivers in Portugal. International Workshop on Uranium, Environment and

Public Health, held at the Instituto Politécnico de Castelo Branco, Castelo Branco, 25 October 2013. Book of Abstracts.

- Fernando P. Carvalho, João M. Oliveira, M. Malta (2013). The national radioactivity monitoring program for regions of old uranium mines and uranium legacy sites in Portugal. International Workshop on Uranium, Environment and Public Health, held at the Instituto Politécnico de Castelo Branco, Castelo Branco, 25 October 2013. Book of Abstracts.
- Fernando P. Carvalho, João M. Oliveira, Margarida Malta (2013). Radioactivity in Soils and Vegetables from Uranium Mining Regions. International Workshop on Uranium, Environment and Public Health, held at the Instituto Politécnico de Castelo Branco, Castelo Branco, 25 October 2013. Book of Abstracts.
- Fernando P. Carvalho (2013). Compliance with Remediation Criteria for Legacy Uranium sites and Monitoring and Surveillance of Uranium Mine Sites. International Workshop on Standard Content of Completion Reports for Decommissioned Uranium Legacy Sites for Central Asia Countries, held at the International Atomic Energy Agency, Vienna, 9-13 December 2013 (INVITED TALK).

EDUCATION AND TRAINING

- Lectures on environmental radioactivity monitoring and radioactivity in water resources to Post Graduation Courses (Mestrado Integrado em Engenharia do Ambiente da FCTUNL), Faculdade de Ciências, Universidade Nova, Monte da Caparica, Almada, 30 April 2013; 19 November 2013.
- Lectures on environmental radioactivity and radiation effects to the Post Graduated Course (Mestrado em Biologia Humana e Ambiente), Faculdade de Ciências, Universidade de Lisboa, Campo Grande, Lisboa, 30 April 2013.
- Evaluator of the Doctoral Thesis presented by Hierro Gutierrez Almuden, to the Universidad de Huelva, Spain, entitled “Behaviour of radionuclides in an estuary affected by industrial wastes and acid mine drainage: the Ria de Huelva” to obtain the “Diploma de Doctorado Internacional”.
- Co-Director of the PhD Thesis of student Juan Francisco Rodrigo Oliva, University of Cadiz, Spain (on-going).
- Supervision and training of IAEA Fellows in radioanalytical techniques at the IST/LPSR:
 - Mr Seydou Djibo, from Niger (3 months)
 - Mr Idrissa Garba, from Niger (3 months)
 - Mr Stanislas Mvondo from Cameroon (3 months).
- Invited Lecturer to the “Advanced Training Course on Marine Radioactivity: Analytical Techniques and Quality Management”. Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, 15-16 July 2013.
- Invited Lectures on environmental radioactivity and monitoring of uranium regions, at Universities and Ministries in countries visited in IAEA missions (Algeria, Burkina Faso, Mauritania, Niger, and Zambia), such as:
- The IAEA “Regional Training Course on Existing Exposure Scenarios (NORM, Past Practices, Radon, etc.) and Remediation Strategies, covering the specific safety requirements regarding public exposure control issues”, held at the Atomic Energy Commission (COMENA), Alger, ALGERIA, 26-30 May 2013.
- The IAEA “Regional Training Course on Uranium mining and ore-processing tailings management”, hosted by Ministry of Mines and Mineral Development, Lusaka, Zambia, 12-18 May 2013.

PROJECTS

- Research project “Definition of new ENdpoints to assess GENtoxic effects resulting from environmental exposures to URanium, Uranium daughters and ionizing radiation in bioindicator species” - ENGENUR. Contract FCT PTDC/AAC-AMB/114057/2009. Total budget: 172,945.00€ (years 2009-2012 extended to 2013). ITN budget: 57,252 €. ITN Coordinator F.P. Carvalho.

- Participation in the education web based project CAPTAR (Web site: captar.web.ua.pt) in the field of environmental sciences. Project coordinated by the University of Aveiro, funded by the Gulbenkian Foundation. IST/ITN Coordinator F.P. Carvalho.
- Submission of proposal to the CEC for a Cost-Action to allowing coordination of Laboratories and Universities on research on biogeochemical availability and transfer of radionuclides and other contaminants from soils to plants of agronomic interest. Coordinated by the University of Toulouse, France. IST/LPSR Coordinator: F.P. Carvalho.
- Submission of a proposal to the EU-Mediterranean Programme for the setup of an international collaborative network (NET-MED) of mediterranean laboratories for the exchange of information and research on environmental radioactivity and radiation safety in the region. Coordinated by Demokritos Nuclear Research Centre, Greece. IST/LPSR Coordinator: F. P. Carvalho.
- Submission of a research proposal to participate in the IAEA Coordinated Research Programme on the characterization of inhalable radioactive particles («hot» particles). IST/LPSR Coordinator: F.P. Carvalho.

CONTRACTS

- F.P. Carvalho (2013). Radiological risk of phosphogypsum. Contract with BAÍA do TEJO (2013-2014). Value: 62,000€.
- F.P. Carvalho (2013), Radionuclides emission by waste incineration: Contract with VALORSUL (2013-2014). Value 10,000€.

CONFERENCE ORGANIZATION / COMMITTEES

- Member of scientific and advisory committees to International Conferences, such as:
- Environmental Health Risk 2013; International Conference on Polonium and Lead Radioisotopes 2013; International Conference on Environmental Rehabilitation 2013; EU-NORM Conference (Madrid); NORM VI Conference 2013; International Conference on Radioecology and Environmental Radioactivity ICRER 2014.
- Carvalho F.P. (2013). Invited to Assistant-Editor of The Science of the Total Environment (Elsevier).
- Carvalho F.P. (2013). EU project Evaluator for the 7th Framework Programme for Research- DG Research and Innovation-Directorate E.
- Carvalho F.P. (2013). Member of the International Atomic Energy Agency Consultant Group to draft an IAEA Technical Report Series monograph on “The Environmental Behaviour of Radium”. (Completed).
- Carvalho F.P. (2013). Member of the International Atomic Energy Agency Consultant Group to draft an IAEA Technical Report Series monograph on The “Environmental Behaviour of Polonium” (On-going).
- Carvalho F.P. (2013). National Contact Point of the ALARA European Network.
- Member of the Advisory IAEA mission for the “Review of Technical Cooperation project design for Mauritania” and Lecturer in the Workshop on Environmental Monitoring Programme, held in Nouakchott, Mauritania, 20-28 June 2013.
- Member of the Advisory IAEA mission for the «Assessment of the need for a national monitoring plan for radioactivity control in environmental, foodstuff and radioactive materials», Ouagadougou, Burkina Faso, 19-23 August 2013.
- Participation in a Technical Meeting on preparation of the International Workshop on Developing and Submitting Completion Reports on Remediation of Uranium Legacy Sites. IAEA, Vienna, Austria, 16 - 20 September 2013.

COLLABORATIONS

- Scientific collaboration with Dra Sónia Mendo, Universidade de Aveiro; Dra Ruth Pereira, Universidade do Porto; Dra Paula Sobral, Universidade Nova; Dra Helena Vala, Instituto Politécnico de Viseu; Dra Sabine Charmasson, IRSN, France; K. Pham, I. Osvath, IAEA Laboratories, amongst many others.

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CATEGORY: Auxiliary Researcher
IST-ID: 25453

ACTIVITIES

| Nº | Activity Description | R&D (%) |
|-------|--|---------|
| 1 | ROBOSAMPLER – Design of a robotic system as a support for radiological and heavy metal monitoring in estuarine environments. | 80 |
| 2 | Third Joint Congress of the Spanish Health Physics and Radiological Protection Societies, Cáceres, Spain, 18-21 June 2013. | 1,8 |
| 3 | Regional Training Course on Harmonization of Procedures for Sampling Techniques, Including Practical Field Exercise, Siebersdorf, Austria, 13–17 May 2013. | 2,7 |
| 4 | National radiological surveillance programme. | 15,5 |
| Total | | 100,00 |

WORK SUMMARY

| Nº | Work Summary and Main Description |
|----|--|
| 1 | <p>ROBOSAMPLER is a joint project coordinated by the Portuguese private enterprise Introsys S.A. in a cooperation with institute Uninova and IST/CTN, with financial support from QREN/IAPMEI/PORLISBOA programme. The aim is to manufacture a robotized system comprised of a terrestrial 4 wheel robot and an autonomous aerial vehicle, devoted to sampling tasks in estuarine mudflats. Operational tests of the accomplished system will be made in the intertidal mudflats of Tejo estuary running from Samouco to Alcochete. Sampling processes will focus on bottom sediments cores, seaweeds and bivalves. During the first year of the project ROBOSAMPLER, IST/CTN personnel was devoted to field exercises with engineers from Introsys and Uninova, aiming to achieve a comprehensive picture of technical and functional requirements. First semester delivered documents comprised technical reports on Requirements and Sensor Module. Second semester was dedicated to field exercises with a terrestrial robotized vehicle prototype - Introbot™ - developed by Introsys and with a build from scratch sediment core collector, hand operated, used as an intermediate tool to gather information on the required force for collecting sediment samples, and also to refine the appropriated design of the device to be applied in the ROBOSAMPLER itself. It is expected that the robotized system will be supplied by the end of March 2014. Field tests and monitoring campaigns will extend to late summer. IST/CTN will process all sampled material for gamma spectrometry analysis and neutron activation analysis.</p> |
| 2 | <p>Poster presentation - Radionucleídos en sedimentos y biota del estuario y del tramo final del rio Tejo, J. Corisco, L. Portugal, M. Almeida.</p> <p>Analysis of bottom sediments supports the assumption that the concentration of the natural radionuclides in the estuarine mudflat upstream the city of Barreiro is not exceeding the values measured for the sediments collected upstream in a section of the river still affected by marine tides (figure 3 of original poster).</p> |

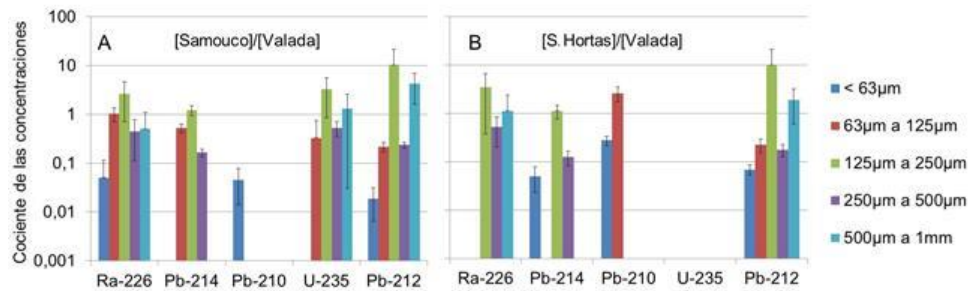


Figura 3. Representación grafica de los cocientes entre las concentraciones de radionucleidos naturales* detectados en las fracciones granulométricas de sedimentos superficiales de la bahía estuarina y del tramo final del río. Cociente <1 significa que la concentración en Samouco (A) o en Sitio das Hortas (B) es menor de la que se mide aguas arriba en Valada (*se excluyen los datos de ^{40}K).

Analysis of the edible parts of bivalve *Ruditapes philippinarum* widely collected in the mudflat for human consumption, indicates the presence of natural radionuclides with concentration levels higher than those measured in the finest deposited sediments (diameter < 63 μm) containing approximately 10% organic matter (table 1 of original poster).

Tabla 1. Concentración de radionucleidos en sedimentos superficiales y almejas *R. philippinarum* del estuario del Tejo en Samouco (C-concentración en Bq g^{-1} , seco; u(C)-incertidumbre de C; CC-cociente de concentraciones $[\text{R. philippinarum}]/[\text{sedimentos}]$; u(CC)- incertidumbre de CC; nd –no detectado).

| | Sedimentos <63mm | | R. philippinarum | | CC | u(CC) |
|---------------------------|------------------|----------|------------------|----------|----------|----------|
| | C | u(C) | C | u(C) | | |
| ^{234}Th | 8,53E-02 | 3,01E-02 | 1,40E-01 | 4,39E-02 | 1,64E+00 | 7,75E-01 |
| $^{234\text{m}}\text{Pa}$ | nd | - | 1,42E+00 | 9,21E-01 | - | - |
| ^{226}Ra | nd | - | 2,00E-01 | 3,66E-02 | - | - |
| ^{214}Pb | nd | - | 4,43E-02 | 1,31E-02 | - | - |
| ^{214}Bi | nd | - | 5,79E-01 | 1,16E-01 | - | - |
| ^{235}U | nd | - | 9,33E-03 | 1,71E-03 | - | - |
| ^{228}Ac | nd | - | 7,52E-02 | 2,72E-02 | - | - |
| ^{212}Pb | 1,62E-02 | 1,07E-02 | 3,71E-02 | 7,21E-03 | 2,28E+00 | 1,57E+00 |
| ^{212}Bi | 8,73E-01 | 3,68E-01 | 1,41E+00 | 6,08E-01 | 1,61E+00 | 9,73E-01 |
| ^{40}K | 8,41E-01 | 1,96E-01 | 3,31E-01 | 2,75E-01 | 3,94E-01 | 3,40E-01 |

Sea weeds *Zostera noltii* covering some areas of the mud flat near Samouco exhibit some measurable concentrations of natural radionuclides, namely isotopes of Pb and ^{226}Ra , which might have some ecological significance relatively to some consumer species (figure 4 of original poster).

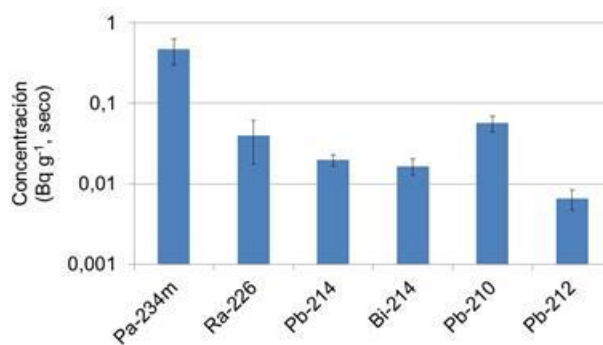


Figura 4. Concentraciones (Bq g^{-1} , seco) de radionucleidos naturales* detectados en hierbas marinas *Z. noltii* de la planicie lodosa de Samouco (*se excluyen los datos de ^{40}K).

3 Regional training course was held under the scope of IAEA Project RER/0/033 “Supporting Quality Assurance for the Measurement and Monitoring of Radioactivity in the Environment”. Sessions at Siebersdorf IAEA facilities and Vienna International Center were devoted to international guidelines for soil and vegetation sampling, description and field practice with sampling equipment, sampling strategies, application of sampling procedures and recording of sampling data.

4 Monthly sampling campaigns in some of the main Portuguese rivers were made in the scope of EURATOM’s treaty article 35°, which stipulates that “Each Member State shall establish the facilities necessary to carry out continuous monitoring of the level of radioactivity in the air, water and soil, and to ensure compliance with the basic standards.”

A systematic sampling of aquatic plants selected by species and ecology has started in October 2013, focused on the objective of selecting available bio-indicators for the monitoring of radionuclides using gamma spectrometry analysis. First available data appear to produce relevant information on ^{226}Ra , ^{228}Ra and ^{210}Pb in the submerged species *Potamogeton pectinatus*, and floating species *Ceratophyllum demersum* at river Tejo (see table).

Table. Concentrations (Bq kg^{-1} , dry) of detected radionuclides in two species of aquatic plants from river Tejo (values in brackets mean the relative uncertainty).

| nuclide | <i>P. pectinatus</i> | <i>C. demersum</i> |
|-------------------|----------------------|--------------------|
| ^{40}K | 292 (11,6%) | 1302 (12,4%) |
| ^{210}Pb | 32,8 (28,8%) | 13,8 (52,5%) |
| ^{226}Ra | 173,7 (4,6%) | 128,2 (7,2%) |
| ^{228}Ra | 25,1 (8,2%) | 10,6 (30,7%) |

COMMUNICATIONS

- *Radionucleídos en sedimentos y biota del estuario y del tramo final del río Tejo*, J. Corisco, L. Portugal, M. Almeida, *Third Joint Congress of the Spanish Helath Physics and Radiological Protection Societies, Caceres, Spain, June 18-21 (2013)*, poster presentation.

PROJECTS

- *Design of a robotic system as a support for radiological and heavy metal monitoring in estuarine environments. (ROBOSAMPLER- LISBOA-01-0202-FEDER-024961)*, POR Lisbon under QREN, FEDER. Leading Institution: Introsys - Integration for Robotic Systems, SA, Moita, Portugal. IST/ITN Coordinator: J. Corisco.

CONTRACTS

- Technical, scientific assistance and consulting contract with Introsys - Integration for Robotic Systems, 1/1/2013-31/12/2014, value 20.009,40 € (plus legal taxes).