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Le quatrième congrès européen de l'IRPA (International Radiation Protection Association) a eu lieu à Genève du 23 au 27 juin 2014. Ce numéro 2 du Volume 39 des Annales de l'Association belge de Radioprotection reprend des articles d'auteurs belges.

Van 23 tot 27 juni 2014 vond te Geneva het vierde Europees congres van de IRPA (International Radiation Protection Association) plaats. Dit nummer, n° 2 van Volume 39 van de Annalen van de Belgische Vereniging voor Stralingsbescherming, herneemt de artikels met Belgische auteurs.

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4th European IRPA Congress

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THE CURE PROJECT: A CONCERTED ACTION FOR AN INTEGRATED (BIOLOGY-DOSIMETRY-EPIDEMIOLOGY) RESEARCH PROJECT ON OCCUPATIONAL URANIUM EXPOSURE

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Introduction

Many exposure situations (occupational, post-accidental, natural radioactivity) involve internal contamination by different radionuclides. Indeed, the major contribution to the radiation dose to the general population is from internal exposure. Studies of internal contamination are also directly pertinent to the better understanding of the impact of differing qualities of radiation and require a close collaboration between epidemiologists, dosimetrists, toxicologists and biologists.

Objectives and Methodology

The quantification of the health effects of internal contamination is one of the major cross-cutting issues considered in the frame of the European Network of Excellence DoReMi (EU FP7). With respect to this objective, the most pertinent epidemiological studies to address this issue are those of workers exposed to uranium (miners and nuclear industry employees involved in the uranium cycle) in which both cancer and non-cancer risks can be examined. Existing cohorts (Belgium, Czech Republic, France, Germany, and United Kingdom) and competences in epidemiology, biology and dosimetry in Europe provide a unique opportunity to develop a collaborative multidisciplinary research project. Nevertheless, the

successful launch of such a project requires careful design, concerted development of a protocol, obtaining ethic agreements, integration of competences and verification of the project's feasibility.

Results

The CURE project is an 18-month “concerted action” supported in the frame of DoReMi and gathering nine European partners. It began in July 2013 and will end in December 2014. Three work-packages have been defined (epidemiology, dosimetry and biology), and the interactions between them are being developed. CURE's aim is the preparation of a common research protocol, and the verification of the feasibility of a molecular epidemiology study integrating epidemiology, biology/toxicology and dosimetry.

Conclusion

Based on the results of this concerted action, the launching of a large scale integrated collaborative project will be possible in Europe to greatly improve the quantification of risks associated to uranium internal contamination.

Acknowledgements

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MEASUREMENT OF PEAK SKIN DOSE AND ESTABLISHMENT OF EUROPEAN ALERT THRESHOLDS FOR INTERVENTIONAL RADIOLOGY PROCEDURES

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Introduction

The extensive use of X-ray fluoroscopy in interventional radiology may lead to severe skin burns and other radiological injuries. To reduce patient's exposure, physicians need to acknowledge patient's maximum skin dose (MSD) in real time. Such a dose indication is not yet available on the currently used X-ray systems and the typically displayed dosimetry data, i.e. fluoroscopy time (FT), kerma-area product (KAP) and cumulative air kerma (CK), must be used for MSD estimation.

Objectives and Methodology

To provide the operator with a real-time estimate of MSD, a measurement protocol was developed by the EURADOS WG12 to establish European alert thresholds for interventional radiology. The data was collected by nine European countries and involved different X-ray systems, operators and methodology. Due to their extensive use of X-rays, the study focused

on the PTCA (percutaneous transluminal coronary angioplasty), NE (neuroembolizations) and CE (chemoembolizations) procedures. First, to measure the MSD, several types of dosimeters were tested including XR-RV3 gafchromic films, TLD chips and TLD foils (LiF:Mg,Ti; LiF:Mg,Cu,P). Next, to identify the most practical and efficient method to measure the MSD, a careful analysis of the measurement results and the associated uncertainties was performed. Finally, the correlation of MSD to the online dose indicators such as FT, KAP and CK as well as to the peak voltage, tube charge, filtration, etc. was investigated. The European alert thresholds were hence defined as a correspondence between the displayed dosimetry value (FT, KAP or CK) and a 3 Gy skin dose; ICRP's threshold for skin deterministic effects.

Results

XR-RV3 films proved to reproduce the 2D skin dose distributions with good accuracy but showed significant dependence with beam energy and quality. Meanwhile, TLDs enabled more accurate dose estimates but the spacing between TLD chips often implicated missing the MSD. Thus, TLD foils were found to be the most adapted tool for the assessment of fluoroscopy-induced MSD. Besides, the MSD showed to correlate best with CK for both CE and NE procedures while it correlated best with KAP in the case of PTCA procedures. Finally, operator's experience and methodology have an impact on the correlation between MSD and CK (or KAP). This brings additional challenge to the definition of European alert thresholds.

Conclusion

Alert thresholds are still needed until real time dose mapping systems become available. The developed MSD measurement protocol standardizes practices of patient skin dose estimates in interventional radiology. The use of CK values as a skin dose indicator represents a promising solution to identify situations associated with high probability of exceeding the dose threshold for deterministic effects. Future steps will include extending the work to other radiology procedures pooled depending on their tube projections, field of view and equipment protocols.

THE EUROPEAN RADIOECOLOGY ALLIANCE: AN INTERNATIONAL COOPERATION INITIATIVE IN RADIOECOLOGY TO GO TOWARDS SUSTAINABILITY

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Abstract

Although current radiation protection standards for the public are generally judged to be acceptably robust, there remain considerable scientific uncertainties with regard to human dose assessments. Moreover, the need for a system to protect the environment from ionising radiation, being now internationally recognized, emphasises the importance to develop radioecological effects research at the various levels of biological and ecological complexity. The acquisition of new scientific knowledge through research in radioecology is crucial to optimise the radiological protection of the public and the environment.

However, despite these major needs there were clear signs that, at the European level, research in radioecology was starting to decline and fragment, to a level where the future needs of end-users, e.g. regulators, society and industry, would not be met. In 2009 the European Radioecology Alliance, ALLIANCE, was formed to counter future challenges for research in radioecology, as well as to maintain and promote competences and experimental infrastructures on Radioecology. In collaboration with the EC-funded projects STAR and COMET, the ALLIANCE developed a Strategic Research Agenda for radioecology, which highlights three scientific challenges, with 15 associated research lines, and is a strategic vision of what radioecology may achieve in the future via a world-wide prioritisation of efforts. A short-term roadmap to implement this SRA is currently under development.

The creation of an ALLIANCE demonstrates the readiness of several organisations to bring together, with an aspiration of sustainability, their research activities in an integrated programme. As a key step, an SRA on radioecology was developed which provides a prioritization of research efforts in this field. Most of these actions will be performed in close collaboration with EURADOS, MELODI and NERIS European platforms, as well as with international organisations involved in radioecology.

Introduction

Although current radiation protection standards for the public are generally judged to be acceptably robust, there remain considerable scientific uncertainties with regard to human dose assessments. Some of these uncertainties could be reduced if there were a better understanding of the behaviour of natural and artificial radionuclides in the environment.

Furthermore, over the past decade it has been recognised internationally that there is a need for a system of radiological protection of the environment. This was the result of an extensive work performed worldwide, including Europe, which made evident the need to explicitly demonstrate that the environment was adequately protected from the hazardous effects of ionising radiation. In this respect, the International Commission on Radiological Protection (ICRP) Recommendations of 2007 incorporates environmental protection as one of the elements of the radiation protection system (ICRP, 2007).

Within the system to protect the environment from ionising radiation, major knowledge gaps remain in the quantification of radionuclide effects on different taxonomic groups of plants and animals. It is therefore important to develop radioecological effects research at the various levels of biological and ecological complexity, in order to have sufficient data and understanding to reduce the current uncertainties in risk assessment. The uncertainties are particularly large for effects from chronic, low level exposures and their potential ecological consequences (i.e. on the structure and functioning of ecosystems).

Therefore, gaining new scientific knowledge through research in radioecology is important to optimize radiation protection of the environment and in turn the public. This knowledge is also important to society because over- or under-estimation of radiological exposure or effects could lead to unnecessary and costly restrictions, or to a lower level of protection for the public or the environment.

In addition an EU-funded project, FUTURAE, found that whilst Europe retains radioecological expertise in a wide range of disciplines, there are currently 'threats' to sustainability as there is considerable fragmentation occurring with the majority of organisations conducting radioecological research having comparatively small budgets and few staff (Vandenhove et al. 2007; Beresford et al. 2007). There is concern that the future needs and requirements from end-users of radioecological research/expertise within

Europe, including regulators, industry, international and non-governmental organisations may not be achievable. Radioecological expertise is needed whenever radiation within the environment is of potential concern. Some examples include the nuclear fuel cycle (from uranium mining through deposition of radioactive wastes); existing, as well as new nuclear power plants; decommissioning of facilities; remediation of contaminated sites; naturally occurring radionuclides (including those of the NORM industries) and nuclear accidents.

Objectives and Methodology

To address future challenges in radioecology, the European Radioecology Alliance, was formed in 2009. The stated intention of the members is to integrate a portion of their respective Research & Development efforts into a transnational programme that will enhance and sustain European radioecological competences and experimental infrastructures. Members of the Radioecology Alliance recognise that their shared radioecological research can be enhanced by efficiently pooling resources among its partner organisations and prioritising group efforts along common themes of mutual interest. A Strategic Research Agenda (SRA)² was seen as a way to progress this prioritisation process. An EC-funded Network of Excellence in radioecology, called STAR (Strategy for Allied Radioecology), was formed in 2011, with a mandate to develop the SRA. More recently, an EC-funded project, called COMET (Coordination and iMplementation of a pan-European instrumenT for radioecology) was launched to further strengthen radioecology, in part by linking with the emergency management NERIS and low dose MELODI platforms.

Results – present situation

The ALLIANCE was formed in 2009, and in 2012 was officially constituted as an Association under the French Law. Since its establishment, 8 new members have joined the ALLIANCE, so that in April 2014 it has 16 members from 12 different countries (Belgium, Finland, France, Germany, Ireland, Kazakhstan, Norway, Poland, Portugal, Spain, Sweden and United Kingdom).

Members of the ALLIANCE bring together parts of their respective research efforts into an integrated programme that maintains and enhances radioecological competences and experimental infrastructures, and

addresses scientific and educational challenges in assessing the impact of radioactive substances on humans and the environment.

Thus, the ALLIANCE members will jointly work to:

- Coordinate and promote research in Radioecology
- Act as a Research Platform, in defining research programmes, resources and identifying priorities
- Promote appropriate exchange of information with relevant organisations, stakeholders and the public
- Participate in future EU funding mechanisms: Horizon 2020

As one of the objectives of the ALLIANCE is to act as a research platform in radioecology, it was felt necessary to develop a long term vision for the future needs and sustainability of Radioecology. The development of a Strategic Research Agenda (SRA) on radioecology was considered a key tool for integration and optimization of resources among those organizations involved in radioecological research activities.

To achieve this, the ALLIANCE, in close collaboration with the Network of Excellence STAR, developed, a Strategic Research Agenda (SRA) for Radioecology (Hinton et al., 2013). The SRA outlines a suggested prioritisation of research topics in radioecology, with the goal of improving research efficiency and more rapidly advancing the science. It responds to the question: “What topics, if critically addressed over the next 20 years, would significantly advance radioecology?”

This SRA prioritises three important Scientific Challenges that radioecology needs to address, including those key research lines required to accomplish each challenge.

Challenge one: To Predict Human and Wildlife

Exposure in a Robust Way by Quantifying Key Processes that Influence Radionuclide Transfers and

Exposure Four key research lines are included in challenge 1:

1. Identify and mathematically represent key processes that make significant contributions to the environmental transfers of radionuclides and resultant exposures of humans and wildlife.
2. Acquire the data necessary for parameterisation of the key processes controlling the transfer of radionuclides.
3. Develop transfer and exposure models that incorporate physical,

chemical and biological interactions, and enable predictions to be made spatially and temporally.

4. Represent radionuclide transfer and exposure at a landscape or global environmental level with an indication of the associated uncertainty.

As a result of the work done in these key research lines, it will be possible to achieve a thorough mechanistic conceptualisation of radionuclide transfer processes within major ecosystems (terrestrial, aquatic, urban). In addition, by incorporating a more profound understanding of environmental processes, a more accurate prediction of exposure to humans and wildlife would be possible.

Challenge two: To Determine Ecological Consequences under Realistic Exposure Conditions

Five key research lines have been prioritised in relation to challenge 2:

1. Mechanistically understand how processes link radiation induced effects in wildlife from molecular to individual levels of biological complexity.
2. Understand what causes intra-species and interspecies differences in radiosensitivity (i.e. among cell types, tissues, life stages, among contrasted life histories, influence of ecological characteristics including habitats, behaviour, feeding regime...).
3. In a broader exposure context, understand the interactions between ionising radiation effects and other co-stressors.
4. In a broader ecological context, understand the mechanisms underlying multi-generational responses to long-term ecologically relevant exposures: maternal effects, hereditary effects, adaptive responses, genomic instability, and epigenetic changes/transformations/processes.
5. Understand how radiation effects combine in a broader ecological context at higher levels of biological organisation (population dynamics, trophic interactions, indirect effects at the community level, and consequences for ecosystem functioning).

As a consequence of the work done in these five key research lines, radioecology will gain a thorough mechanistic understanding of the processes inducing radiation effects at different levels of biological organisation, including the consequences on ecosystem integrity, and be

able to accurately predict effects under the realistic conditions in which organisms are actually exposed.

Challenge three: To Improve Human and Environmental Protection by Integrating Radioecology

Within Challenge three, six key research lines have been identified:

1. Integrate uncertainty and variability from transfer modelling, exposure assessment, and effects characterisation into risk characterisation.
2. Integrate human and environmental protection frameworks.
3. Integrate the risk assessment frameworks for ionising radiation and chemicals.
4. Provide a multi-criteria perspective in support of optimised decision-making.
5. Integrate ecosystem services, ecological economics and ecosystem approaches within radioecology.
6. Integrate Decision Support Systems.

The knowledge gained in these six research lines, will allow radioecology to develop the scientific foundation for the holistic integration not only of human and environmental protection, but also of their associated management systems.

The first version of the SRA was critically reviewed by stakeholders via an on-line questionnaire and invited workshop that resulted in an updated version produced in 2013 (available in www.radioecology-exchange.org). Currently, the ALLIANCE is working towards developing a first 5-year roadmap for the radioecology

SRA together with partners in the COMET project. This short-term roadmap will serve as a basis for the development of an implementation plan to initiate a limited number of priority research activities that have been identified in the SRA. The roadmap is focused on research areas that have strong interaction with two other pillars of radiation protection: emergency response and management of post accidental situations covered by the NERIS and low dose risk covered by MELODI platforms.

Another key objective of the ALLIANCE is to collaborate in the coordination and integration of research activities in the field of radiation protection at national, European and international level. This integration is a key aspect

in the EURATOM Horizon 2020 framework programme. The cooperation between MELODI, ALLIANCE, NERIS and EURADOS was initiated under the EU’s Seventh Framework Programme for Research (FP7) and more in particular in the form of a project called “OPERRA” (Open Project for the European Radiation Research Area, figure 1). OPERRA aims at establishing the necessary structures for managing long-term European research programmes in radiation protection. In December 2013 the ALLIANCE, MELODI, NERIS and EURADOS signed a Memorandum of Understanding (MoU) to confirm their joint commitment towards the consolidation and implementation of a strategic vision of radiation protection research in Europe. The signatory organisations decided to establish a Joint Radiation Protection Research Roadmap Committee, with the aim to coordinate as necessary their respective strategic research agendas and priority roadmaps. Further joint working groups will be set up in areas of common concern, for the benefit of European radiation protection research.

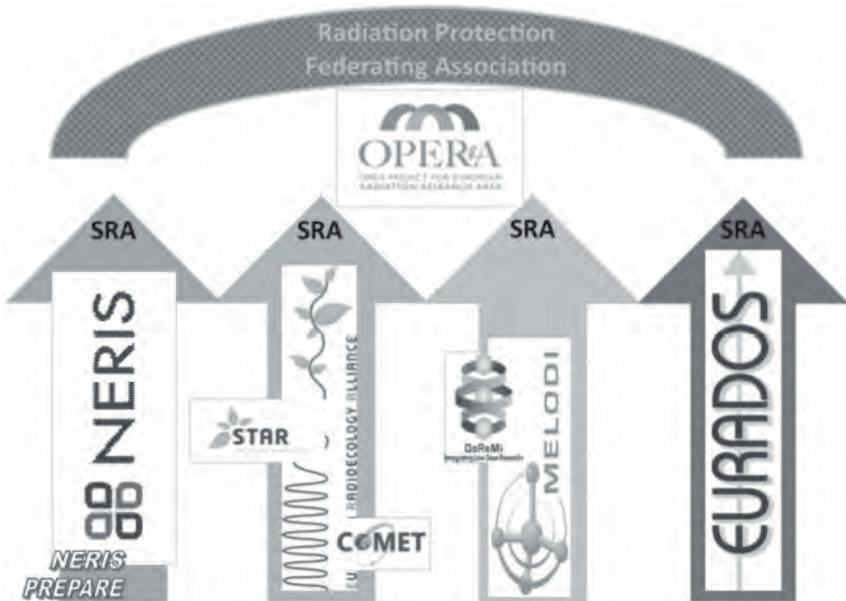


Fig. 1. Preparing the Future - Radiation Protection Research

ALLIANCE has also signed a MoU with the International Union of Radioecology (IUR: <http://www.iur-uir.org/en/>), to cooperate in the promotion of a common strategy and in the implementation plans for

research in environmental radioactivity and radioecology, and to conduct joint activities.

Conclusions

The establishment of a European Radioecology Alliance brings together organisations committed to bringing parts of their respective research and development activities into an integrated programme that maintains and enhances radioecological competences and experimental infrastructures, and addresses scientific and educational challenges in assessing the impact of radioactive substances on humans and the environment. Through the STAR network of excellence, it was possible, together with the ALLIANCE, to develop a Strategic Research Agenda for radioecology that prioritises the important that radioecology needs to address. In addition, a 5-year roadmap and associated implementation plan is currently under development, in collaboration with the COMET project. The ALLIANCE will develop its activities in close connection with the EURADOS, MELODI and NERIS European platforms. The Radioecology Alliance is an association open to other organisations engaged in radioecology both within Europe and worldwide, whose aims are to maintain, enhance and promote radioecology (www.er-alliance.org).

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DYNAMIC EXTERNAL DOSE ASSESSMENT BY LES MODELING OF RADIOACTIVE POLLUTANT DISPERSION OVER AN OPEN FIELD

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An essential part of the nuclear emergency planning is the estimation of the external dose to the general public after the accidental release of radioactive gases. This is in particular important in order to be able to take effective countermeasures. Although Gaussian models are frequently used to assess atmospheric pollutant dispersion after accidental releases, they are known to have a limited accuracy close to the source or in situations with complex air flow. One alternative in these situations is the use of Computational Fluid Dynamics (CFD) with Large Eddy Simulation (LES) turbulence modeling. By coupling a LES model with a beta and gamma dose rate model, not only an improved accuracy is obtained, but also the dynamic behavior of the external dose rate is quantified. In the current work, we study this dynamic behavior, primarily focusing on the differences between the beta and gamma dose rates. We use an Eulerian approach to simulate the pollutant dispersion from a stack release over an open field under neutral atmospheric stratification. The evolution of the concentration is formulated as a transient three-dimensional convection-diffusion problem where the sub-grid scale (SGS) pollutant flux is modeled based on an eddy-diffusivity approach. In order to impose a realistic representation of the wind field, the instantaneous profiles for velocity and eddy viscosity are produced by a large eddy simulation of the atmospheric boundary layer in which the SGS viscosity is evaluated using a Lagrangian scale-dependent dynamic model. From the concentration, beta and gamma dose rates are computed at every instant using the point-kernel method with buildup factors. The model is applied to the dispersion of the unstable isotopes Argon-41 and Xenon-133. Both disintegrate by beta minus decay

into a stable daughter, accompanied by the emission of gamma radiation. It is observed that even under constant pollutant emission rate, strongly fluctuating dose rates in time are registered, regardless the isotope. In addition, a strong dependence of this variation on the distance from the stack is observed. To illustrate, for the gamma dose rate at ground level these fluctuations are in the order of 50% at a distance of 500 m from the stack up to a factor three at a distance of 1.5 km. For the beta radiation, these fluctuations are even pronounced with variations in dose rate of several orders of magnitude in time. Effort is currently put into the translation of these results into an improvement of the present monitoring strategy in the vicinity of nuclear installations.

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DOSIMETRY APPROACHES FOR THE ASSESSMENT OF CUMULATIVE EYE LENS DOSES FOR RETROSPECTIVE EPIDEMIOLOGICAL STUDIES ON INTERVENTIONAL RADIOLOGISTS AND CARDIOLOGISTS

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Introduction

The recurrent occupational exposure to radiation of the eye lens has become a real concern for interventional medical professionals since it may lead to the development of lens opacities. Epidemiological studies on the relation between eye lens dose and the occurrence of lens opacities require the knowledge of cumulative eye lens dose for the whole working period.

Objectives and Methodology

In the framework of the European ELDO project (funded by the DoReMi Network of Excellence), two approaches were hence developed to retrospectively estimate cumulative eye lens doses for interventional radiologists and cardiologists. In the first approach, the recently established European ORAMED eye lens dose database was used while accounting for the evolution of the X-ray systems and procedures over the last 50 years. This method requires the knowledge of the type of interventional procedures carried out by each physician for his whole working period, the workload, the use of X-ray systems and radiation protection means, etc. Meanwhile, in the second approach, eye lens dose was estimated from whole body doses using correlation coefficients established through a large

measurement campaign. Monte Carlo simulations were also considered in this approach to determine the variation of eye lens and whole body doses when ceiling shields or lead glasses are used.

Results

In the first approach, information on the evolution of X-ray systems was collected from the manufacturers to adjust recent eye lens dose values for procedures performed before the year 2000. Hence, a correction factor of 2 to 4 was identified accounting for the change in beam filtration, detectors' upgrades, change in frame rate, etc. Cumulative eye lens doses were next calculated for 14 different interventional cardiologists for whom sufficient information on the workload and the use of X-rays and radiation protection systems was available. Meanwhile, for the second approach, the conducted measurements showed eye lens dose to correlate, with the lowest uncertainty, with collar left whole body dose (Left eye/collar Left= 3.3, spread 42%); the typical chest left records remained however exploitable but with higher uncertainties on eye lens dose calculation. Besides, Monte Carlo simulations provided the necessary coefficients to correct the obtained correlation coefficients when radiation protection equipment is used. Finally, cumulative eye lens doses were again assessed for the same cardiologists based on available chest left whole body dose records.

Conclusion

This work suggests two practical and easily exploitable approaches to assess cumulative eye lens dose for the purpose of retrospective epidemiological studies on interventional radiologists and cardiologists. However, considering the associated uncertainties, these methods should not be considered for the routine monitoring of eye lens doses for interventional procedures where a dedicated dosimeter remains necessary.

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RADIOACTIVITY IN FOOD: MEDIA REPORTING AND PUBLIC ATTITUDES

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Introduction:

In case of accidental radioactive releases to the environment leading to contamination in the food chain, the public perception of food safety will be an important aspect of post-accident management, alongside the evaluation of potential health effects. Media plays an important role in this respect.

Objectives and Methodology

The purpose of this study was to answer a number of research questions:

- How did media report about radioactivity in food after the Fukushima accident? Is there a difference between highest quality newspapers and popular newspapers?
- What is the public perception of low levels of radioactivity in food products after an accident and what are the driving factors behind the willingness to consume such products?

Media reporting was studied using content analysis of 110 articles discussing the radioactive contamination in the food chain published in four Belgian newspapers: a highest quality newspaper and a popular newspaper in each of Dutch and French languages. The data on public acceptance of radioactivity in food products originate from a large scale (N>1000) public opinion survey in Belgium carried out in August-September 2013. The survey method was Computer Assisted Personal Interviewing, the field work being done by a professional company with trained interviewers.

Results

Even though intensive efforts are dedicated in Japan to the recovery process, food and related environmental contamination with radioactive pollutants occupied a side role in the overall Belgian reporting about the

Fukushima accident. The main source of information used by the media was opinion makers/givers, in their majority independent experts from academic institutions in Belgium or abroad.

Limited attention was given to preparedness for nuclear/radiological emergencies in view of the lessons learned from the Fukushima accident, the articles focusing mostly on the early to medium post-accident management phase. Measurement units specific to radiation were reported in less than 20% of the articles analysed. Risk comparisons used by the media mainly related to legal norms and, to a lesser extent, to the natural radioactivity background. Notably, a popular newspaper had the highest frequency and the wider spectrum of risk comparisons including also comparisons with medical examinations, historical contaminations or natural radioactivity in food products. In the second part of the study, a logistic regression showed that attitude and beliefs related to food products with radioactivity levels below legal norms, social norms and trust in legal norms influence the intention to consume such products.

Conclusion

The study proves that public reassurance on food safety issues remains a main challenge. The preparedness phase should get more attention also in terms of public information. Media use often comparisons with legal norms; however trust in the food norms is relatively low. Anxiety, concerns about health effects and justification are among the driving forces for the non-acceptance of food products with residues of radioactivity.

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DO WE CARE? FEELING OF SOLIDARITY IN THE CASE OF NUCLEAR ACCIDENTS

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Managing the consequences of nuclear accidents is costly and in many cases exceeds national budgets and expertise. In order to recover from the consequences of the accidents in Chernobyl and Fukushima, the international community has provided assistance to the affected societies and to the affected people. Help from different institutions is frequently reported in international documents (e.g. help provided by IAEA), whereas the feeling of solidarity among general, not-affected population is not scrutinized. Do people living far from the accident care? How much and how long? Do the nuclear disasters have a power of the mobilization of world's sympathy and support? If they do, do these feelings last for a longer period, or willingness to help and share the consequences disappear with new events appearing on the first pages of newspapers? The research is empirically grounded on public opinion survey addressing feelings of sympathy and solidarity in Belgian population (n>1000) and media content analysis of Belgian press reported about the nuclear accident in Fukushima. Results of this research are added value for better decision-making in nuclear emergency preparedness and response and enhanced interaction of radiation protection field with a society.

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HOW DOES THE MASS MEDIA REPORT AND INTERPRET RADIATION DATA? THE RESULTS OF A MEDIA CONTENT ANALYSIS

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In communication with the general population, experts often provide quantitative information related to ionizing radiation, expressed with different units of radioactivity. However, quantitative information about radiation risks may be meaningful only to people who have the ability to comprehend basic numerical concepts and possess knowledge related to radiation. Thus, the media, as a bridge between experts and the general population, has to “translate” quantitative information into a qualitative one. How successful and accurate are the mass media in this transformation of scientific results into publicly understandable information? Our research investigates media reporting on the concept of ionizing radiation in a case of nuclear emergencies. The presentation is focused on summarizing the «lessons learned» from the use of radiation data in media reporting about the Fukushima nuclear accident. The in-depth media content analysis was conducted in twelve quality newspapers in Belgium, Slovenia, Italy, Spain, Norway and Russia using the same scientific methodology and analyzing the same time period. Preliminary results identified miss concepts of radiation data by media and even within emergency responders and decision makers. The research is a result of FP7 project Innovative integrated tools

and platforms for radiological emergency preparedness and post-accident response in Europe – PREPARE and upgraded with a Russian experience.

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A RIVER RUNS THROUGH IT: ENVIRONMENTAL REMEDICATION OF THE MIXED CONTAMINATION OF THE WINTERBEEK RIVER IN A MULTI-LEVEL REGULATORY CONTEXT

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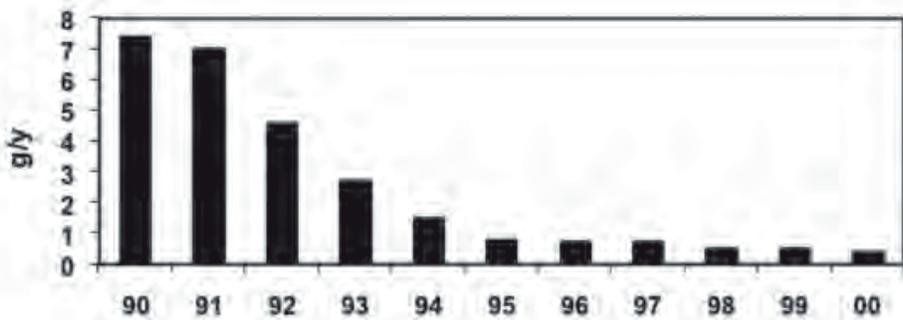
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For several decades, industrial production of dicalciumphosphate for cattle food with the hydrochloric acid process has led to contamination of the Winterbeek, a small river in the north-east of Belgium. Until 1995, considerable amounts of heavy metals and salts, among which ²²⁶Ra, were released daily through liquid discharge into the river, contaminating the riverbed sediments. Subsequent dredging of the riverbed and periodic flooding events have spread the contamination to the riverbanks and through the zone of marshlands and interconnected smaller rivers of which Winterbeek is part. The radiological contamination caused by ²²⁶Ra, with dose rates up to 10 times the normal background levels, accompanies high levels of chemical contamination by cadmium and arsenic above the remediation levels defined by regulations. Therefore a remediation project has been initiated.

Radiological and heavy metal contamination

Sulfuric acid, sulphate and phosphate have been produced on a large scale by a chemical company in the study area starting in 1919, discharging waste water containing radium, important amounts of CaCl₂ salt and heavy metals (mainly Cd). Due to important improvements to the chemical

process, the radium load in the waste water was reduced from about 20 Bq/l in the early 1990's to less than 2 Bq/l in the early years 2000. This has led to a decreasing radium discharge to the Winterbeek stream from about 7g per year to 0.35 g/y (Fig. 1). A similar decrease occurred in the discharge of Cadmium from 12 T/y to 0.1 T/y. Considering the salt load to the river too high and too harmful to the environment, the authorities decided that the discharge of salt had to be stopped by the end of 2013. This led to the end of the production of phosphate at the end of 2013. Nevertheless, due to the years-long discharge the Winterbeek stream and its flooding zone have become seriously contaminated over a length of about 17 km. A significant surface area is contaminated, including the river shores and its flooding zone (~721 ha of which 63000 m² with a volume of 190000 m³ is contaminated) and the river bottom sediments (~19000 m³).



A detailed characterisation with airborne gamma spectrometry (Thomas et al., 2006, Poffijn and Pepin, 2005) of the contaminated area indicated that about 59000 m² of the Winterbeek river valley shows gamma dose rates above 150 nSv/h (Fig. 3). The average radium concentration in the river bank sediments is 0.8 Bq/g for the left bank and 1.3 Bq/g for the right bank.

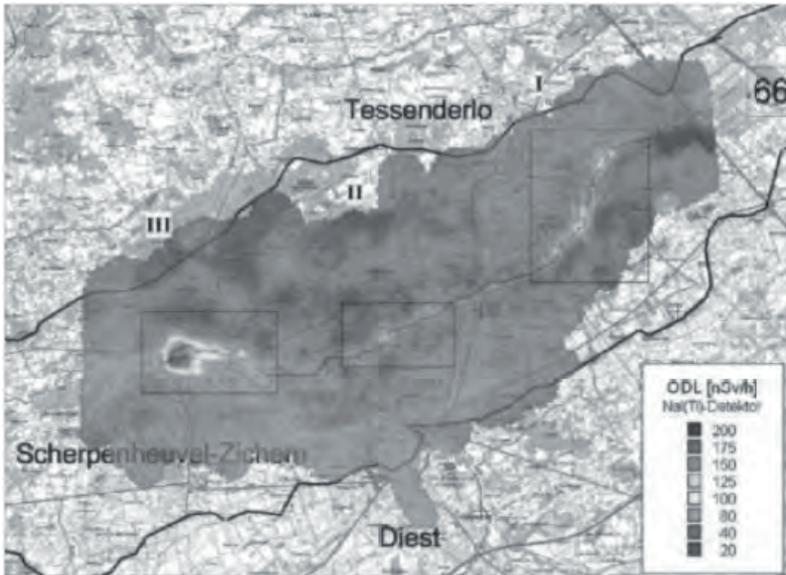


Fig 2. Airborne gamma spectrometry of the Winterbeek valley indicating about 59ha of contaminated land with > 150 nSv/h.

Earlier studies (Poffijn and Goes, 2003) had already shown the statistical link between the radium activity concentration in the ground and the gamma dose rate measured at about 1m above the ground surface (Fig. 3). Further investigations showed the statistical relation between the gamma dose rate at 1m above the surface and the cadmium concentration in the ground (Paridaens, 2008). It was shown that in general, the remediation reference level of 6 mg/kg Cd dry substance corresponds to gamma dose rates above 150 nSv/h. This is true only if the contamination of cadmium and radium are present close to the surface and if the contamination is not covered by a clean soil layer.

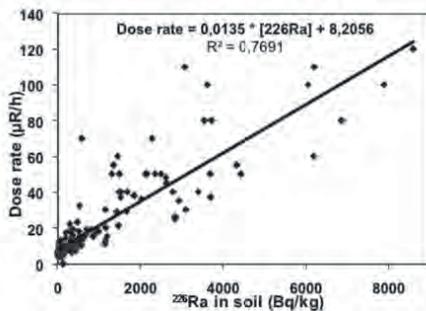


Fig 3. Correlation between the gamma dose rate at 1m above the ground and radium content in the ground

Detailed analysis of samples taken in the stream sediments and at various depths in the sediments underlying the stream sediments indicate that radium, as well as cadmium, have been leached into the ground. Figure 4A provides an indication of the contamination in the river bed (sediments) as a function of the distance to the mouth of the stream into a larger river. Ra-226 varies between 400 and 2500 Bq/kg. Figure 4B shows the contamination of the underlying soil under the sediments layer of the river bed. Fig. 5 shows the comparison between Ra-226 activity concentration in sediments and in underlying soil. Values are higher for the sediments except close to the discharge point.

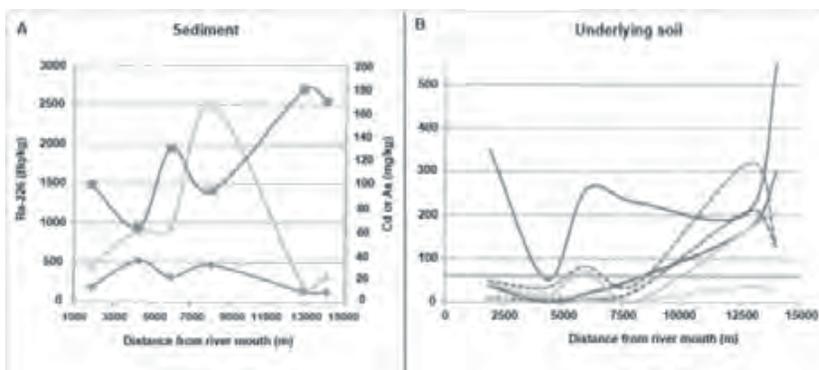


Fig. 4: **A.** Contamination in the sediments between the discharge point and the mouth of the stream (Ra-226: green, Cd: blue and As: red). The first point starting from the right corresponds to a location close to the discharge point. **B.** Contamination in the underlying soil between the discharge point and the mouth of the stream. Ra-226 activity concentration (in Bq/kg) is shown on the continuous lines; cadmium concentration (in mg/kg and times a factor 10 to match the unit of Ra-226 activity concentration) on the dashed line. Blue, red and green lines correspond to a depth of respectively 0-20cm, 20-40cm and 40-60cm.

Remediation in a multi-level regulatory context

Justified by the high levels of cadmium, a remediation project for the Winterbeek river has been initiated, which also takes into account the radiological component. In Belgium however, chemical contamination and its remediation is regulated by the regional authorities (OVAM), whereas the regulation of radiation protection resides at the federal level (FANC). This situation potentially leads to a discrepancy between regulatory and remediation goals for chemical and radioactive components. Furthermore, additional stakeholders such as the national radioactive waste management

agency (NIRAS) may also be involved in the process. The approach for mixed contamination was therefore based upon the modular graded approach to remediation of chemical contamination used by the regional authorities. This process, which starts with identification and characterisation of the site and ultimately leads to feasible remediation options, involves all stakeholders from operator to authorities. A more detailed description of this process may be found in (Mannaerts et al. 2011). A specific multi-disciplinary / multi-agency (including FANC) working group pilots the remediation of the Winterbeek river. While the radioactive component is not the main trigger for this remediation project, the participation of FANC in the working group assures that radiation protection aspects are taken into account in the process.

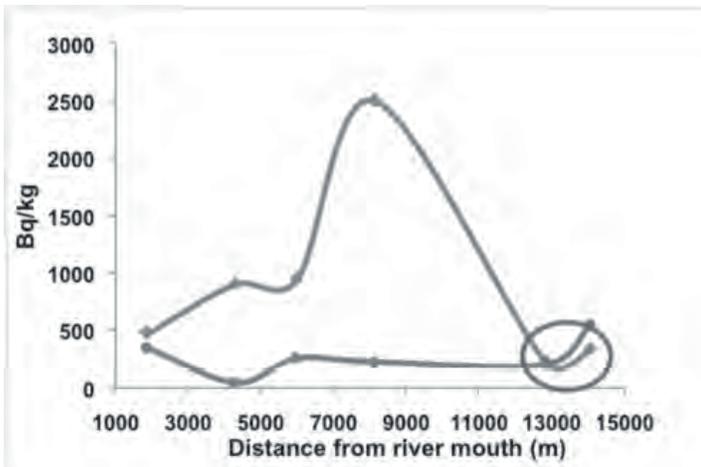


Fig. 5: Early disturbance of the river sediments inverting the contamination ratio between sediment (in blue) and underlying soil (in red).

In particular for the Winterbeek river case, remediation of the riverbank is complicated by the large variation in land use along the 17 km stretch which is considered in the remediation plan. Different aspects and effects of the co-contamination come into play in different sectors. Weighing ecotoxicological and radioprotection considerations and the information from the descriptive soil investigation, as well as taking into account the practical (e.g. accessibility of the contaminated zone), ecological (some grounds are considered as “ecologically vulnerable”), sociological and financial aspects, a remediation option has been attributed to each sector

of the river. These remediation options range from complete restoration of the riverbanks to complete absence of physical intervention (restricted land use). The completion of the remediation project is projected to take 1.5 years. For the riverbed, a removal of the sediment up to the risk level for cadmium has been retained, which should lead to the excavation of ~37,000 m³ material. The sediments and the underlying soil of the Winterbeek and contaminated tributaries will be removed down to an acceptable risk value for this project. The external gamma dose rate of 150 nSv/h will be used as an operational level for this remediation. Based upon a correlation between Cd and Ra contamination, this should lead to the removal of > 90% of Cd contaminated soil above 6 mg/kg. It should also ensure sufficient removal of the radiological component. Considering the shielding effect of overlying clean soil and the statistical uncertainty, the correlation between Cd and Ra concentrations has to be treated with care. For the remediation of the river bank, soil will be removed down to the risk value (see above) where possible, or to the ground water level. In naturally sensitive areas, remediation of the river bank will be limited to the natural levees. These operations should lead to the excavation of an additional 53,000 m³ of contaminated material. In residential and agricultural areas, the river bank will be restored to the current level and covered with vegetal mats to prevent erosion, whereas in other areas this will be only done if it is justified by the hydrological regime or the need for containment of remaining contamination. In some areas which are very vulnerable from an ecological viewpoint, the burden of the remediation activity itself outweighs the ecological damage inflicted by the contamination, and no action will be undertaken. The remaining contamination in the soil (e.g. under ground water level) will be contained and managed by adding a layer of clean soil on top of the contaminated layer. The exposure risk will be managed by issuing practical recommendations for soil use. In places where the contamination will not be removed, restrictions on the use of the ground will be imposed (no deep ploughing, restriction on crops and grazing of cattle, ...). The erosion of the remaining contamination in sediment or riverbed also needs to be monitored and will be contained by placing sediment traps in the stream.

The material from riverbank and (where possible) the river bed will be pumped hydraulically to a site where it can be dewatered and prepared for road transport. All of the excavated material is to be disposed on a landfill

site owned by the operator of the company which was at the origin of the discharge in the Winterbeek stream.

Conclusion

The Winterbeek case shows how closely radiation protection aspects can be entangled with other environmental factors in a remediation project. It underlines the necessity for a multi-disciplinary approach and for a dialogue between all stakeholders, including the different authorities involved. It also shows the practical and operational limits of remediation options in difficult accessible areas.

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SETTING UP THE EURADOS STRATEGIC RESEARCH AGENDA: VISIONS ON DOSIMETRY RESEARCH FOR THE NEXT 20 YEARS

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Introduction

The European Radiation Dosimetry Group (EURADOS) is a self-sustainable network of nearly 60 European institutions. The aim of the network is to promote research and development and European cooperation in the field of dosimetry of ionizing radiation. It includes experts, reference and research laboratories, and dosimetry services. This enables specialist groups to be formed to solve scientific problems or to promote research. EURADOS organises a yearly successful annual meeting, and specific training events like training courses, winter schools and scientific symposia. The main scientific activities are done through eight active EURADOS working groups on “Harmonization of Individual Monitoring in Europe”, “Environmental Dosimetry”, “Computational Dosimetry”, “Internal Dosimetry”, “Radiation Protection Dosimetry in Medicine”, “Retrospective Dosimetry”, “High Energy Radiation Fields”, and “European Medical ALARA Network”.

Objectives and methodologies

Since 2012, EURADOS is in the process to develop a Strategic Research Agenda (SRA), in an effort to provide input for the OPERRA (Open Project for European Radiation Research Area) initiative. The goal of OPERRA is to establish a framework that will allow coordination of future research projects in radiation protection on behalf of the EC. The first version of the SRA was developed by input from all working groups, and compiled and written by an Editorial Group installed by the EURADOS Council.

Results

The goal was to develop visions how in the next 20 years research in dosimetry is expected to contribute significantly to scientific advances and to the improvement of the radiation protection system. These visions are grouped into 3-5 scientific challenges, including a vision statement of what should be accomplished, and followed by a strategic research agenda of key research lines required to accomplish this vision. In this first version, the EURADOS SRA includes five visions related to fundamental dose concepts and quantities, dosimetry for epidemiological cohorts, dose assessment in case of radiological emergencies, integrated personalized dosimetry in medical applications, and radiation protection of workers and the public. The SRA also includes statements on the future needs in Education and Training, and describes actions to harmonise dosimetric practices in Europe.

The next step is that this first version will be presented to the EURADOS Voting Members for feedback. Another important step is to organise stakeholder involvement. All relevant organisations will be invited to participate and actively contribute to the SRA, through a dedicated meeting.

Conclusion

EURADOS has been a successful and self-sustained organization for many years. To structure its activities, and to be active in the OPERRA network, an SRA was developed through a process involving many EURADOS members and stakeholders. This EURADOS SRA will be updated periodically through a dedicated procedure with wide involvement.

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**THE EUROPEAN PLATFORM
ON PREPAREDNESS FOR NUCLEAR
AND RADIOLOGICAL
EMERGENCY RESPONSE AND RECOVERY**
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The NERIS platform was established in June 2010 to encourage European, national, regional and local authorities, technical support organisation, operators, professional organisations, research institutes, universities, and non-governmental organisations to cooperate and to facilitate access expertise and technology in maintaining competence in the field of nuclear emergency management and recovery for the benefit of European countries and citizens. 49 organisations are members of the NERIS Platform from 24 countries and 20 members are supporting organisations. The NERIS Association has been registered in August 2012 as a legal European Association under the French Law. It is operated by a management board of 10 members and the NERIS R&D Committee elaborates its strategic orientation. A secretariat is in charge of the technical administration (e.g. website - www.eu-neris.net, publication of 'Newsletters'). 3 Working Groups have been set up: - on « the practical implementation of the ICRP recommendations »; - on « processes and tools for emergency and rehabilitation preparedness at community level »; - on "Contaminated Goods" Users group on decision support systems are also working under the umbrella of the NERIS Platform: the RODOS Users Group (RUG) and the "Handbook user group". The NERIS Platform also supports the organisation of training courses on "Usage of the new products for supporting

the management team” organised by VUJE, «Preparedness and Response for Nuclear or Radiological Emergencies» organised by SCK•CEN and “Late Phase Nuclear Accident Preparedness and Management” organised by CEPN. The NERIS Platform is linked to research projects, managed by KIT: - NERIS TP “Towards a self sustaining European Technology Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery”. -PREPARE project on innovative integrative tools and platforms to be prepared for radiological emergencies and post-accident response in Europe. To set up a common reflection, cooperations have been established with European and international organisations: HERCA, ALLIANCE, CRPPH, ICRP and AIEA. To share issues on lessons learnt from the Fukushima accident, cooperation have been initiated with IGES (Institute for Global Environment Strategies) and with the Fukushima University. The NERIS Platform is also involved in the steering committee of the EC Project OPERRA, aiming at structuring the research in the field of radiation protection at the horizon 2020. This paper will present the key components of the NERIS Platform and its objectives.

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PREPARE: INNOVATIVE INTEGRATED TOOLS AND PLATFORMS FOR RADIOLOGICAL EMERGENCY PREPAREDNESS AND POST-ACCIDENT RESPONSE IN EUROPE

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PREPARE: Innovative integrated tools and platforms for radiological emergency preparedness and post-accident response in Europe The European research project PREPARE with 45 partners from all over Europe that started February 2013 and will end beginning of 2016, aims to close gaps that have been identified in nuclear and radiological preparedness following the first evaluation of the Fukushima disaster. Among others, the project will address the review of existing operational procedures for dealing with long lasting releases, cross border problems in monitoring and contaminated goods management and further develop missing functionalities in decision support systems ranging from improved source term estimation and dispersion modelling to the inclusion of hydrological pathways for European water bodies. The project will also investigate the conditions and means for the public to access reliable and trustworthy information during emergency and post-emergency contexts and to effectively contribute to protect itself in the perspective of the Aarhus Convention (article 5.1.c). In addition, as the management of the Fukushima event in Europe was far from optimal, a so called Analytical Platform will be developed exploring the scientific and operational means to improve information collection, information exchange and the evaluation

of such types of disasters. The tools developed within the project will be partly integrated into the two decision support systems ARGOS and RODOS. Further methods and tools will be made available for scientific or operational institutions to complement decision support systems. The Analytic Platform may have the potential to become a European centre for collecting and evaluating information and therefore has to be self-sustaining. It is important to note, that improvements can only be made by fostering the interaction between science, operational emergency centres and other key stakeholders at national and European levels, and by improving communication with the public. This can be achieved in following-up the successful activities started in the European project NERIS-TP and with the NERIS Platform (NERIS – European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery), which comprise the key players in Europe. The paper highlights the key objectives of the PREPARE project and informs about the methods and tools to become available by January 2016.

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