PROJECT FINAL REPORT

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Project acronym: DETECT

Project title: "Design of optimised systems for monitoring of radiation and radioactivity in case of a nuclear or radiological emergency in Europe **"**

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Project website Error! Bookmark not defined. **address: http://detect.sckcen.be**

[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

4.1 Final publishable summary report

Executive summary

In case of nuclear or radiological emergency the fast delivery of comprehensive information on the existing or future radiological situation is essential for decision making in the early stage of an emergency. Whatever tools are available they have to be judged if they improve decision making. Monitored data and modelled information, used independently or together, have to support decision making allowing the authorities to initiate appropriate measures at the right time. Up to now, monitoring and modelling is often used separately which can be easily recognised looking at support organisations with departments for monitoring and departments for emergency response. In planning new monitoring networks, systems or strategies the same modelling tools can be applied to achieve optimised results. This project collects all relevant factors needed in planning monitoring systems (stationary or mobile) and develops a methodology that uses the supporting modelling tools in order to design optimised systems for different monitoring purposes.

Following the Chernobyl accident, many countries have set up monitoring networks of different types and densities and with different objectives. In Germany, the main purpose of the automatic network of ambient dose rate was to capture the path of a cloud coming from outside the country. Other European member states followed different strategies resulting in a very patchy density when compared over Europe. This ranges from 11 fixed stations for example in Denmark up to more than 1000 stations in Germany. More than 20 years later European countries are in the process evaluating the current monitoring networks with the objective to define new goals given new monitoring techniques available but also taking into account the well advanced capability of decision support systems. Countries such as Finland, France and Germany are in the process of upgrading the networks. In this respect also resources necessary to maintain the network have to be considered.

Decision making requires the usage of both monitored data and modelled information as they complement each other. Ideally both information are available in one platform and are combined for the usage of the decision making team. Emergencies can be subdivided into several phases with different needs for decision making. In the pre-release phase, prognostic information from models build the basis for decision making and in the later phases following the release phase, monitored data becomes more and more important. Models are in this stage mainly used for the prognosis of the evolution of the contamination but not longer to define its location and characteristics. In the release phase, modelling and monitoring are both important and recent work has combined both information via data assimilation approaches aiming to improve the analysis of the radiological situation and the forecast of the modelling systems. Important in this respect is that monitoring and modelling information fit together as otherwise no added value can be expected.

One of the objectives of the Euratom FP7 Fission and Radiation Protection Programme is a joint European action aiming at more coherent national monitoring systems and decision support systems, and more fluent exchange of data and information between the European countries. This is of special importance since Europe is the most complicated region in terms of the number of nuclear/radiological facilities and number of countries with different languages, politics and cultural backgrounds. Therefore this project aims to emphasise the European and regional dimensions in place of national arrangements.

Summary description

Harmonisation of environmental radiation monitoring networks is extremely valuable with respect to approaches used and equipment installed. Therefore, we aim at developing a European methodology which allows quantifying the pros and cons of a monitoring system to be installed on a local, national or regional level. Defining monitoring strategies has to account for the given situation, among others, the phase of the accident, release scenario and location as well as the criteria of the decision making team. In this respect, there is no single strategy or information which is appropriate for all possible scenarios.

It is important to stress again, that this consortium is convinced that monitoring and modelling capabilities have to be combined and cannot be treated independently. Nevertheless, the analysis and also the development of monitoring strategies will always consider the simulation capability in each European country. Having no Decision Support System (DSS) installed, the results of this study can be still used to explore and optimise monitoring strategies. Nevertheless, optimised results are expected for the combination of both.

The objective of this project is to improve decision making by developing a methodology and planning tool for optimising monitoring systems in Europe. This will be achieved via:

- Elicitation of the most important criteria for the decision making in the early phase of an emergency
- Evaluation existing information on monitoring strategies
- Analysis of the equipment available at present
- Project recent development in monitoring equipment for the use in a strategy in future
- Analysis of the most important release scenarios and define which monitoring strategy is most effective for this
- Definition of success criteria for the operation of monitoring networks depending on country specific needs and demands
- Providing simulated “measurements” for testing
- Development of an accident scenario data base for the collection of all relevant information for a given event/scenario combination
- Development of an easy to use tool for defining the best strategy including other factors such as monetary, social and political constraints

Demonstration of the applicability of the methodology in country-specific scenarios.

Main S&T results/foregrounds

The main scientific and technological result of this project is a planning and optimisation tool that allows the end users to test and develop environmental radiological monitoring strategies for their specific needs. This software tool compiles the knowledge that has been gained with the country-specific scenario calculations and combines it with the monitoring guidelines available from the Member States. It is intended as a stand-alone easy-to-use JAVA based application with a graphical user interface.

The DETECT Optimisation Tool (DOT) is based on a comprehensive library of simulations of radioactive plumes from 64 sources (threats) in Europe that were identified to be most important by the users. The simulations cover whole Europe, so the tool allows evaluation and optimisation for all EU countries as well as evaluation of fencing sensors around the sources. Together with the users, seven cost functions have been developed to evaluate the capability of a given monitoring network to (early) detect radioactive plumes and to allow the generation of dose maps. The tool runs on a server and can be accessed via a graphical user interface (GUI). Users can run evaluations and optimisations and display, store, and download the results.

The DOT is based on a comprehensive database of plume simulations from the RIMPUFF dispersion model. The source terms cover the span of typical half-lives and deposition characteristics. Weather data of a full year was used to generate 292 plumes from each of 64 release points within Europe. Simulations on European and on regional scale allow estimating the potential impact of an atmospheric release of radioactivity from nuclear power plants to countries or to the vicinity of the plants.

The user can choose among seven cost functions to evaluate the goodness of a given network. Four of these criteria determine how well the sensors detect plumes; they can focus on plumes threatening settlements or on early detection. Two test the quality of interpolated maps based on measurements at the sensor sites, e.g. to delineate evacuation zones. Besides, a geometrical criterion can be used to evenly spread the sensor in the whole region.

Networks can not only be evaluated, but also optimised by a greedy search algorithm that can determine the (almost) optimal number and location of sensors to reach a desired detection capability, taking into account already existing sensors or select among proposed sensor locations.

The graphical user interface of the tool provides GIS functionality to visualise the locations of plume sources and sensors as well as some maps of the simulated plumes as overlay over a general map (open street map). These maps can be zoomed and panned. Cost for different monitoring networks can be compared and the cost development during optimisation is given as graph. This interface can also be used to select sources from which plumes should be used, to scale the source term, and to upload and change sensor locations. Further it provides control to the underlying computations. The results can be downloaded in a convenient format comprising an automatic report of the main characteristics. They are also stored in the database of the tool for further use.

On the use of the DETECT Optimization Tool (DOT)

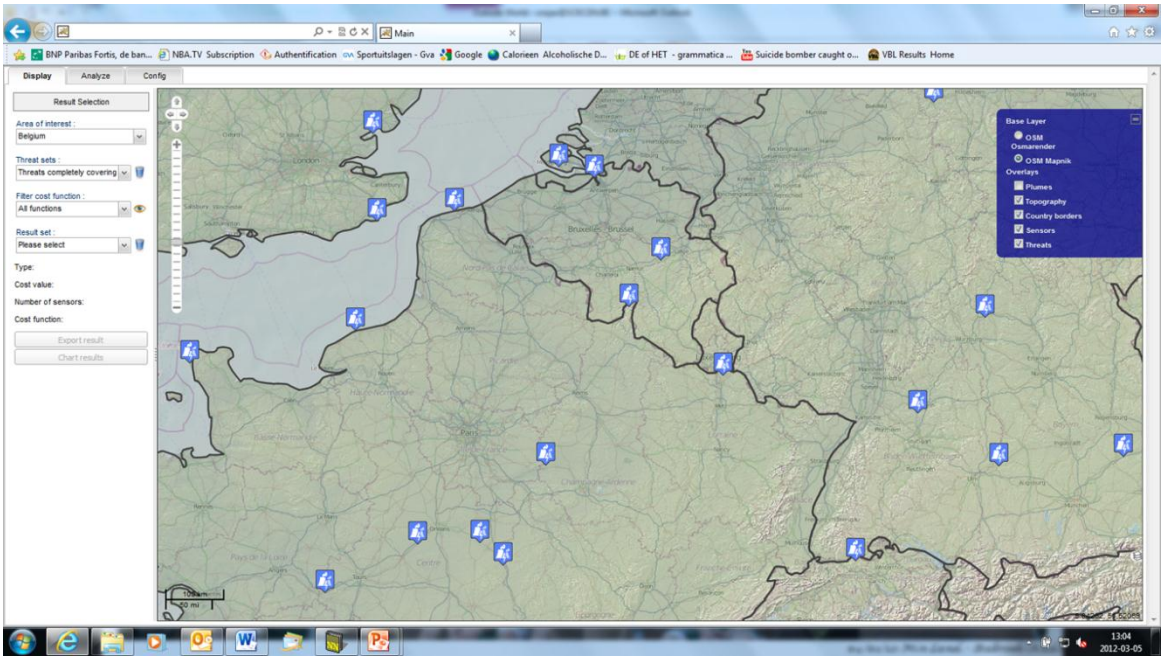
As mentioned above, DOT is available through secured access to a web server http://jrodos.fzk.de/Detect/ and is solely intended to be used by EU national competent authorities engaged in nuclear emergency preparedness, response and planning. DOT can also be distributed on a dual layer DVD and after installation a virtual machine environment will be created on the local host, this allows its use on a local machine without needing internet access to the server. The latter installation requires a computer with preferably more than 16 GByte RAM. There are known computing time issues associated with the optimization process in large countries such as France or Spain, and this can be resolved by expanding the memory allocation capacity. DOT comes with a detailed users guide to facilitate its use even by inexperienced users. DOT will be made available through the ECURIE and EURDEP networks in close collaboration with the European Commission's DG Energy. It has to be pointed out that the DOT is as such a planning tool and neither the consortium as a whole or the individual partners are to be held responsible for damages implied or otherwise resulting from the use of this tool.

Screen shots

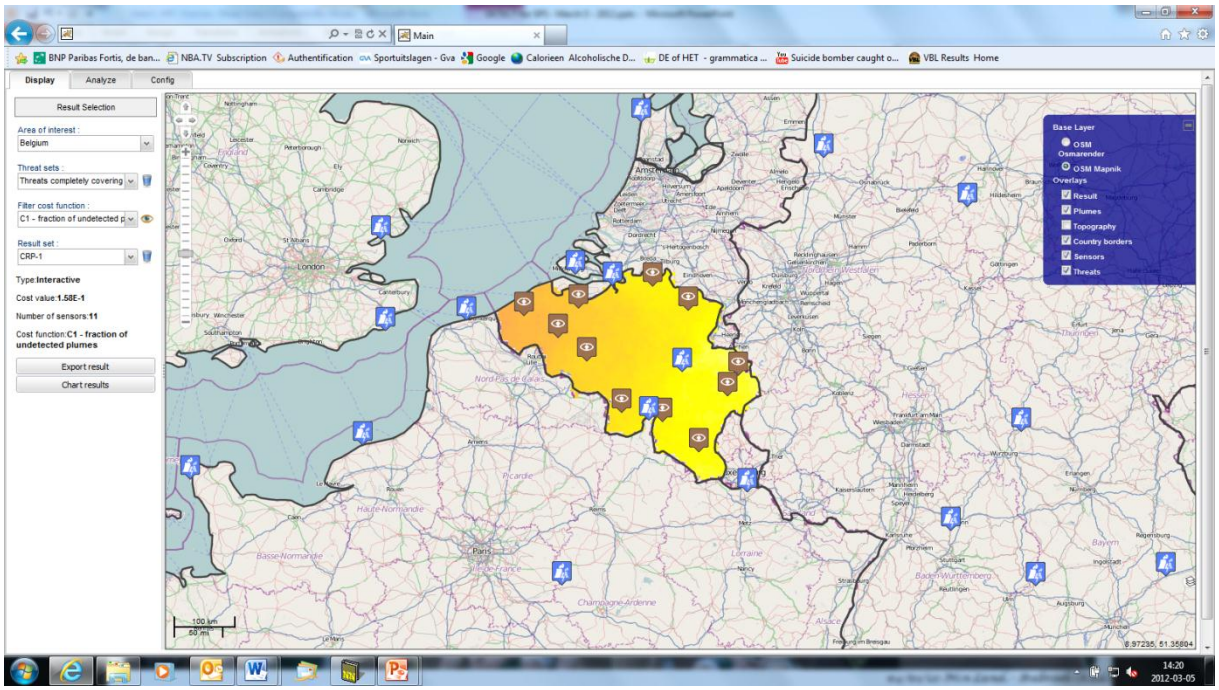
End user identified threats that are considered in DOT

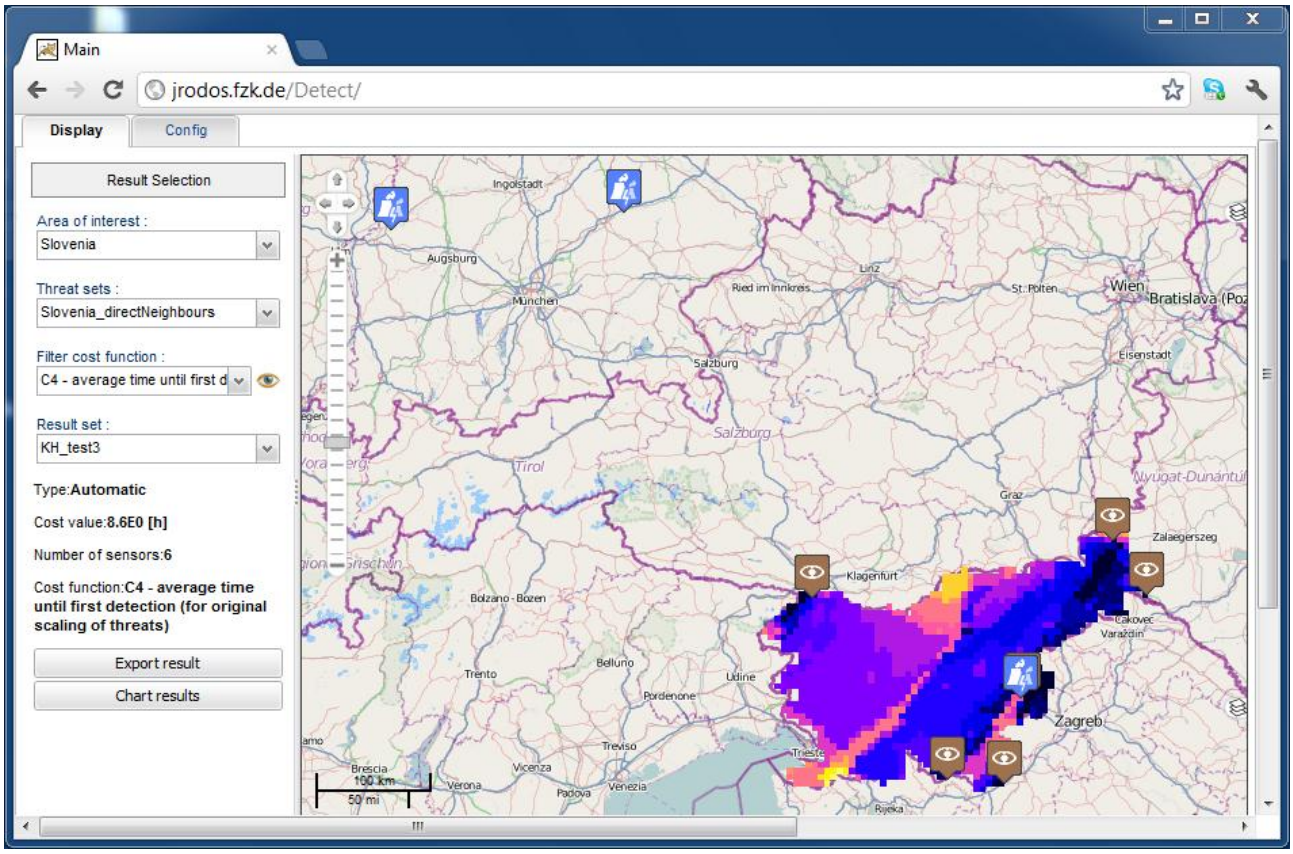
GIS user interface

DOT includes a GIS system that allows to display the threats that are to be considered in the optimization



Example of the optimization for Belgium





Graphical User interface with result of an optimisation for Slovenia

The DOT is implemented using the Google Web Toolkit (Java to Javascript cross-compiler), thus allowing online access from a very wide spectrum of devices. The online requirement is a standard web browser. It can also be installed locally for confidential use. This virtual machine provides out-of-the-box installation and usability to end users. It includes a complete system with backend, frontend, webserver, GIS, and necessary data to start work with the tool immediately. The backend, which is based on the open source software R, can be run separately by users who want to develop it further.

Potential socio-economic impact and the wider societal implications of the project

This project produced a tool to optimise the deployment of environmental radiological monitoring devices to be used during nuclear emergencies in conjunction with portable resources. This application will be mainly used by nuclear regulators and nuclear emergency response organisations, which are interested in either renewing existing monitoring capabilities installed post Chernobyl or design new networks using state-of-the-art technological advances. The adoption of the outcome of this research project will ensure the early detection of any accidental or incidental release of radioactivity to the environment, which in turn will result in an early deployment of countermeasures to protect members of the public.

All stakeholders associated with nuclear emergency response and environmental monitoring of radioactivity should be interested in the outcome of this project.

The plans for disseminating the outcome of this project include a dissemination workshop and presentations organised by DG Energy for the ECURIE and EURDEP communities. A general public live demonstration at the International Radiological Protection Association conference in Glasgow in May of this year will consolidate the visibility of the DOT as a valuable tool for planning preparedness and response in the event of a major release of radioactivity at or affecting the EU.

Project Website

Further information on the project can be obtained from http://detect.sckcen.be

4.2 Use and dissemination of foreground

- Section A:

  As indicated above, the outcome of this project will be further disseminated through the European networks ECURIE and EURDEP. The detect optimisation tool will be available to all EU national competent authorities and nuclear emergency preparedness and response authorities, which can either opt for the on-line web application or installing it on a dedicated computer using a virtual environment. DOT will be further disseminated at the International Radiological Protection Association conference, and it is expected that emergency response planners will become acquainted with the main features of DOT.

- Section B

  There are no confidentiality issues associated with the outcome of this project.

Section A (public)

This section includes two templates

- Template A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.
- Template A2: List of all dissemination activities (publications, conferences, workshops, web sites/applications, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters).

These tables are cumulative, which means that they should always show all publications and activities from the beginning until after the end of the project. Updates are possible at any time.

NO.	Title	Main author	Title of the periodical or the series	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers[2] (if available)	Is/Will open access[3] provided to this publication?
1	An assessment methodology for monitoring networks of weak radioactive plumes after nuclear emergencies	L. Urso	Environmental Modelling & Software	Elsevier	Online	2012			Yes
2	Optimising spatial sampling designs to detect overlapping	Helle	Geostats		United Kingdom	2012			

[2] A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

[3] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

	discrete objects								
3	Planning sensor locations for the detection of radioactive plumes for Norway and the Balkans	Helle	Radioprotection	J. Barescut, D. Lariviere and T. Stocki (Eds.)	France	2011	55 - 61	http://dx.doi.org/10.1051/radiopro/20116628s	
4	Comparison of Mapping Methods for Plumes Using Prior Knowledge from Simulations	Helle	Proceedings of the Seventh International Symposium on Spatial Data Quality	Fonte Cidalia C, Goncalves Luisa, Goncalves Gil	Portugal	2011	15 - 20		Yes
5	Conservative Updating of Sampling Designs	Helle	Proceedings of the Ninth International Symposium on Spatial Accuracy Assessment in Natural Resources and Environmental Sciences	Tate Nicholas J., Fisher Peter F.	United Kingdom	2010	181 - 184	http://spatial-accuracy.org/HelleAccuracy2010	Yes
6	Overview over sampling design for atmospheric monitoring based on simulations; comparison of optimisation algorithms (Upper Austria)	Helle et al.	Spatio-Temporal Design	J Mateu, WG Müller (eds)	United Kingdom	2011			Yes

List of project meetings and venues

1. Kick off meeting, July 6 – 7, 2009, Brussels (BE)
2. Users Group meeting, October 12 – 13, 2009, Roskilde (DK)
3. Work Package 2 technical meeting, June 24, 2010, Munich (DE)
4. DETECT contractors' meeting, September 9 – 10, 2010, Oslo (NO)
5. Technical meeting WP2 (UoM, HMGU), March 21-22 2011, Munich (DE)
6. User workshop April 3-6 2011, Plitvička Jezera (HR)
7. Technical meeting WP2 (SCKCEN, KIT, UoM, NRPA), May 13 2011, Brussels (BE)
8. Technical meeting WP2 (KIT, UoM), September 27 2011 Karlsruhe (DE)
9. User workshop November 14-16 2011, Madrid (ES)

Section B (Confidential[4] or public: confidential information to be marked clearly)
Part B1

N.A.

[4] Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

Part B2
N.A.

The foreground of this project will be exploited by granting access to EU National nuclear emergency preparedness and response authorities to the DETECT Optimisation Tool. This will be done either by providing login details after registration or through the installation of the DOT on a virtual environment created on a local desktop computer.