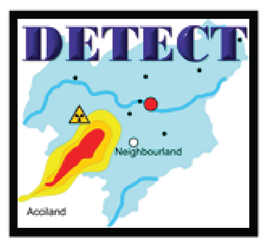
Design of optimised systems for monitoring of radiation and radioactivity in case of a nuclear or radiological emergency in europe (DETECT)

Carlos Rojas-Palma[1], Poul Astrup [2], Kristina Helle[3], Tim Müller[4], Thomas Schichtel[4], Jan Erik Dyve[5] and Laura Urzo[6]

[1]Belgian Nuclear Research Centre (SCK•CEN) // [2]Danish Technical University // [3]University of Münster, Germany // [4]Karlsruhe Institute of Technology, Germany // [5]Norwegian Radiation Protection Authority // [6]Helmholtz Zentrum Muenchen Deutsches Forschungszentrum fuer Gesundheit und Umwelt Gmbh



Introduction

In the aftermath of the Chernobyl nuclear accident in 1986, many European countries installed monitoring systems for radioactive contamination in the environment. These systems are linked together through a network and serve the purpose of providing early warnings against nuclear accidents. Many of the older monitoring systems require updating, and some areas would benefit from new networks built with state-of-the-art technology. The European Commission funded a research project, DETECT that had as primary objective the development of a tool to optimise the deployment of environmental radiological monitoring devices to be used during nuclear emergencies, in some cases in conjunction with portable devices. This tool helps to ensure that nuclear regulators and nuclear emergency response organisations can quickly detect any accidental or incidental release of radioactivity into the environment.

Project Objective

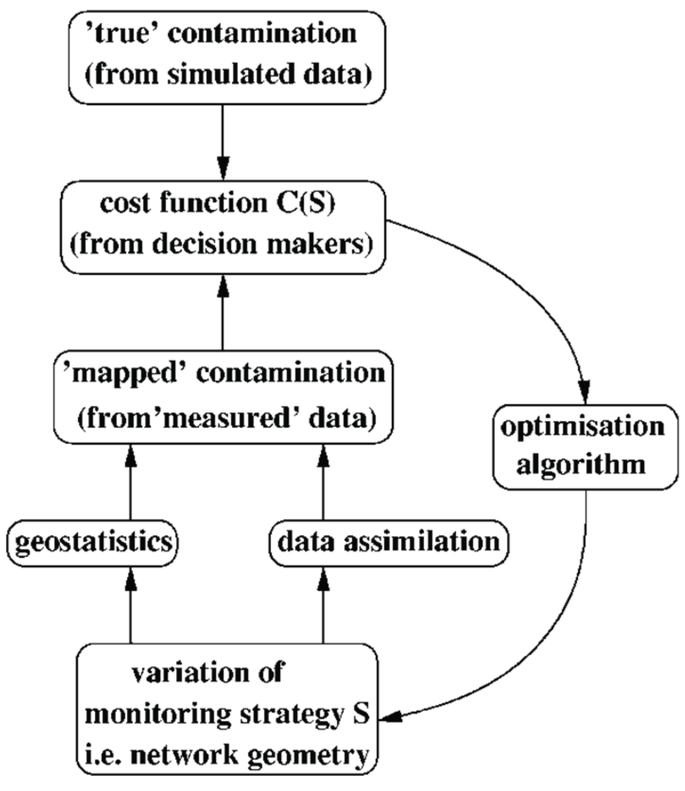
The objective of this project is to improve decision making by developing a methodology and planning tool for optimising monitoring systems in Europe.
This will be achieved via:

- 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

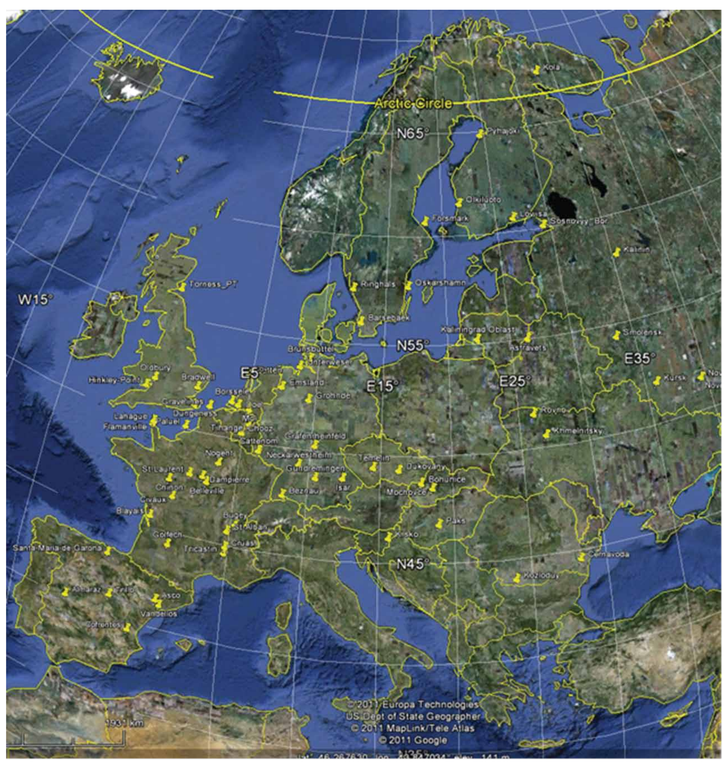
Demonstration of the applicability of the methodology in country-specific scenarios.

Methodology

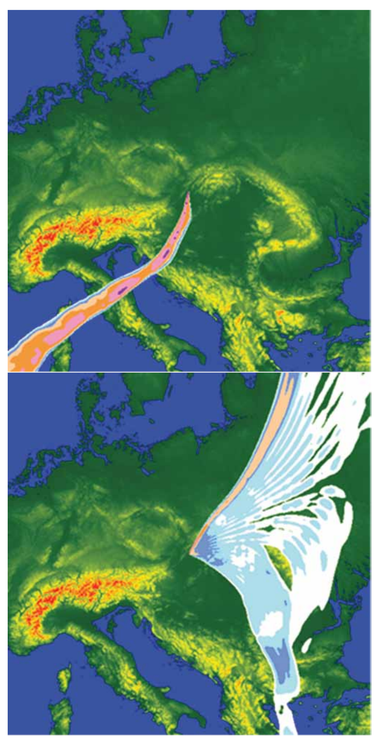
Locations of gamma dose rate sensors have often been chosen by administrative or geometrical criteria. Nowadays computational capacity allows for a more realistic basis. We use simulations of potential radioactive plumes based on weather data of one year to investigate the threats to regions without own nuclear power plants and to find good numbers and locations of sensors to detect such plumes. We optimise sensor locations by minimising a cost function that can take into account numbers of undetected plumes, their dose to the region in general, or on the population.



Threats



Atmospheric dispersion model results library



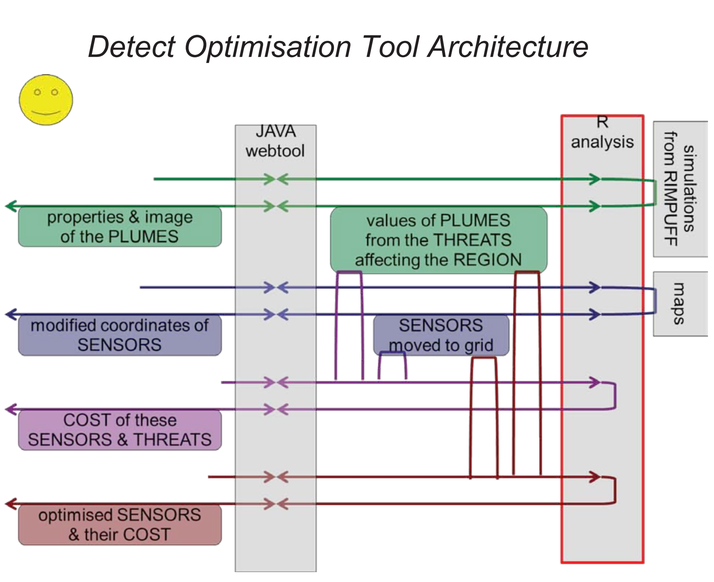
Main scientific/technological foreground

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 Optimization Tool (DOT) is based on a comprehensive library of simulations of radioactive plumes from 64 sources 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.

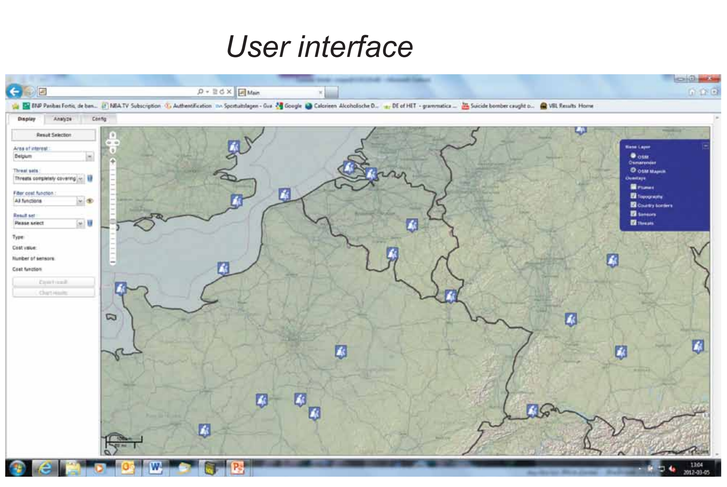
The user can choose among seven cost functions to evaluate the goodness of a given network. Four of these criteria determine how well the sensors detect plumes; they can focus on plumes threatening settlements or on early detection. Two test the quality of interpolated maps based on measurements at the 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 optimized 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 visualize 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 optimization 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.

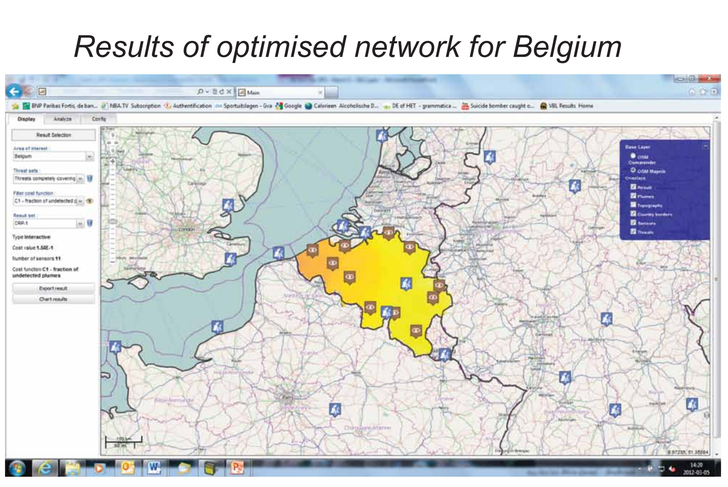
Detect Optimisation Tool Architecture



User interface



Results of optimised network for Belgium



Dissemination

The outcome of this project will be demonstrated during the conference and subsequently at the ECURIE and EURDEP meeting organised by DG Energy in Luxembourg. Plans for organising a dissemination workshop are also being considered.

Acknowledgements: This project has been partially funded by the Euratom FP7 programme under grant agreement 232662.

Contact: carlos.rojas.palma@sckcen.be

www.sckcen.be
info@sckcen.be
201209_CRojasPalma