Probabilistic Accident Consequence Evaluation (PACE)

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A Tool for Assessing the Ranges of Consequences of Potential Accidents at Nuclear Sites

Introduction

The UK Office for Nuclear Regulation (ONR) is currently assessing two new designs put forward for a new generation of nuclear power stations to be built in the UK. The process of assessing the suitability of nuclear power stations includes a generic design assessment (GDA) followed by a site-specific assessment of the power station in the proposed location. One part of an assessment is to look at health and other impacts of a proposal for the building, operation and decommissioning phases and also during potential accident conditions.

The assessments of accidents are undertaken probabilistically and, in anticipation of this, the HPA is undertaking the development of a modern, sophisticated software tool for the purpose of carrying out such assessments. The tool is called Probabilistic Accident Consequence Evaluation (PACE).

PACE is currently being developed at HPA's Centre for Radiation, Chemical and Environmental Hazards (CRCE). An in-house version is already in use but the development project continues to add extra features for commercial release. A commercial version for sale is expected to be available in the medium term for level 3 probabilistic safety analysis (PSA).

What PACE Does

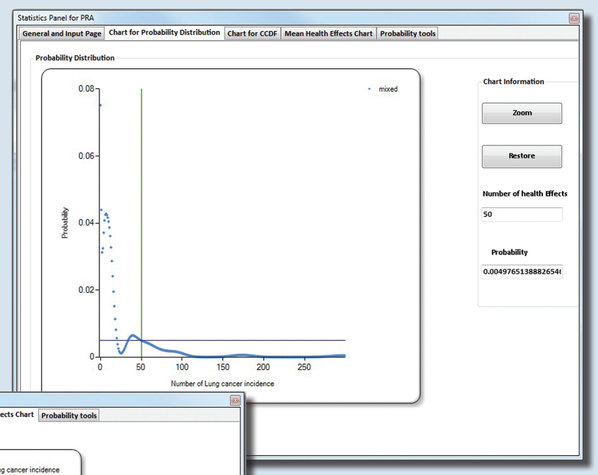
PACE models the atmospheric dispersion and deposition of radionuclides from a given accident scenario. It calculates individual doses to the population from radioactive material in the plume and on the ground and collective doses from radioactive material in the food chain. PACE estimates numbers of health effects, both deterministic and stochastic, in the population. It predicts what countermeasures such as evacuation, sheltering, stable iodine prophylaxis, relocation, food restriction and decontamination will be required, and it calculates the effects of those countermeasures on both doses and numbers of health effects. In addition it predicts the economic costs such as health consequences and the clean-up operation.

Features

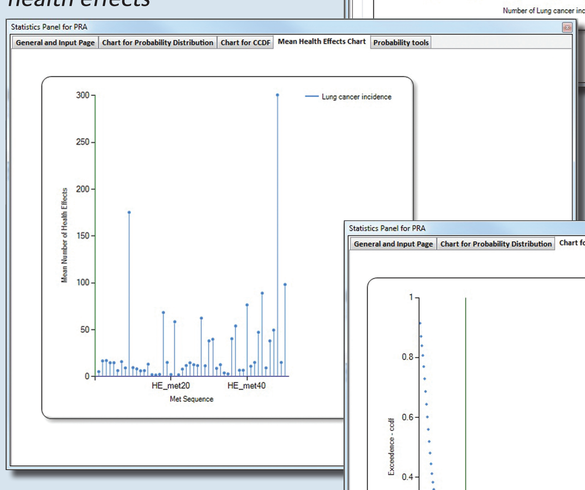
- PACE has been developed within the commercial ESRI ArcGIS™ Geographic Information System. This takes advantage of the various features in ArcGIS™ in order to handle spatial data, create sophisticated visualisations and perform analysis of the results.
- The software database contains data on population and land use for the UK. This is being extended to include the rest of the EU and the software is designed to be compatible for use all over the world provided the relevant local data is available.
- PACE includes the option of modelling the dispersion of materials using a Gaussian plume model (ADEPT) or the UK Met Office NAME III Lagrangian atmospheric dispersion model. Both approaches make use of real weather samples taken from around the site.
- A statistical methodology will allow the user to create graphs of outputs such as doses or countermeasures. PACE assesses the probability of a consequence from a given range of input conditions.
- Countermeasure options and decontamination packages will be included and will be available for customisation by the user. The consequences of an accident with and without these enacted, and hence the averted doses, may be calculated.

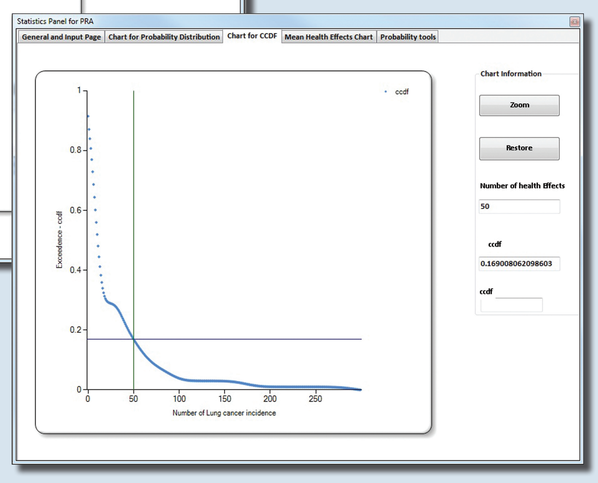
Examples of the statistical distributions presented by PACE for 50 sequences of meteorological data for the projected number of lung cancer cases in each met sequence.

Probability distribution



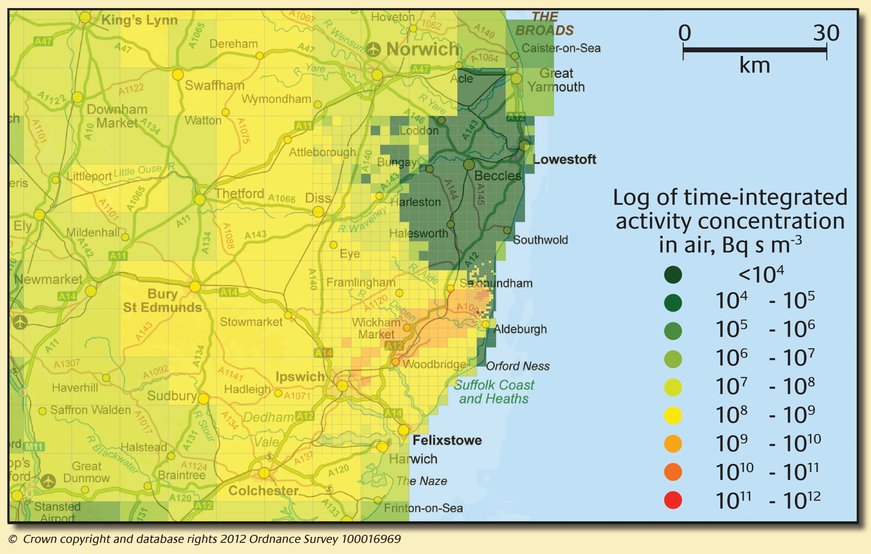
Mean number of health effects



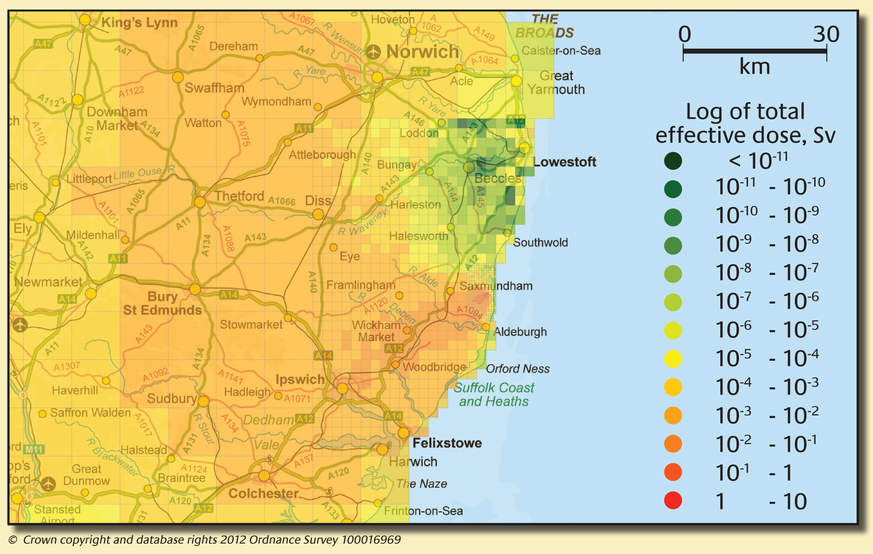


Complementary cumulative distribution function (ccdf)

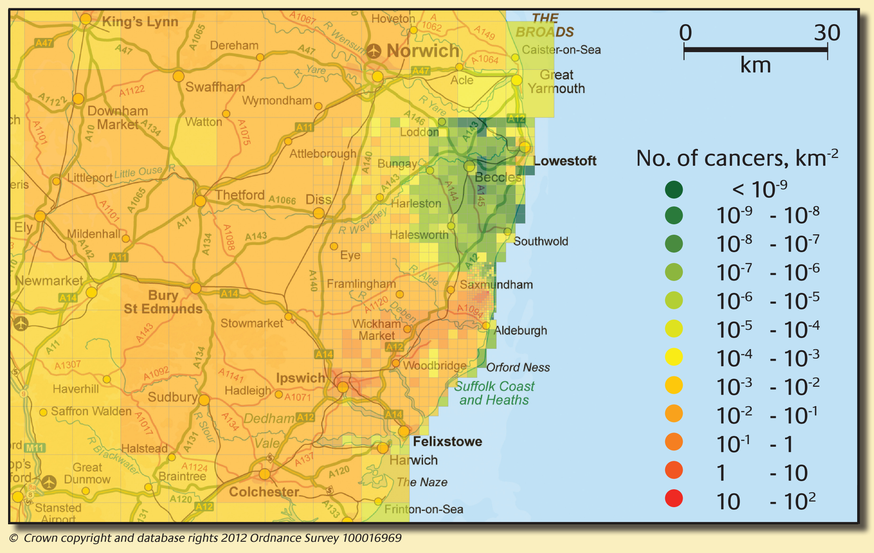
Projected Time-integrated Activity Concentration in Air of Iodine-131 from a Hypothetical Incident in East Anglia



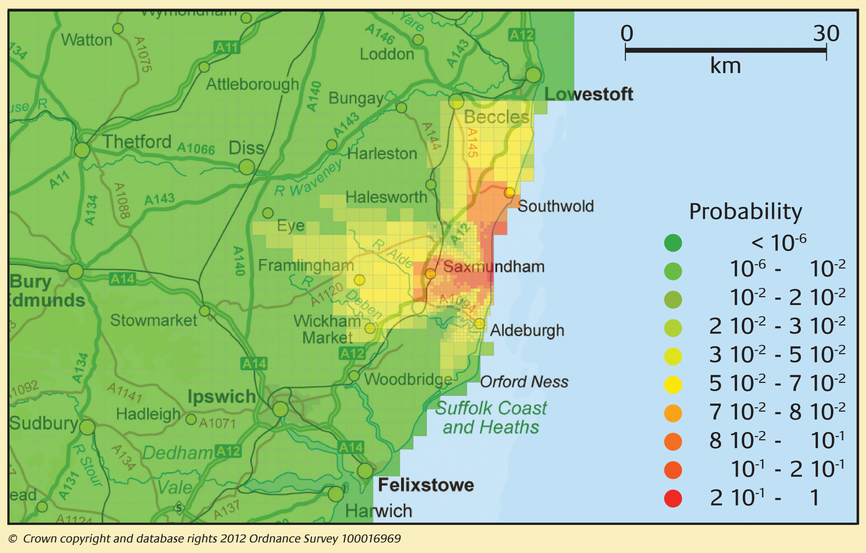
Projected Effective Dose to Adults Resulting from a Hypothetical Incident in East Anglia



Projected Number of Health Effects Resulting from a Hypothetical Incident in East Anglia (Lung Cancer Incidence per Unit Area)



Percentile Map Showing the Probability of Evacuation Following a Hypothetical Incident in East Anglia
(Probabilities calculated from a PACE run using over 100 sequences of meteorological data)



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