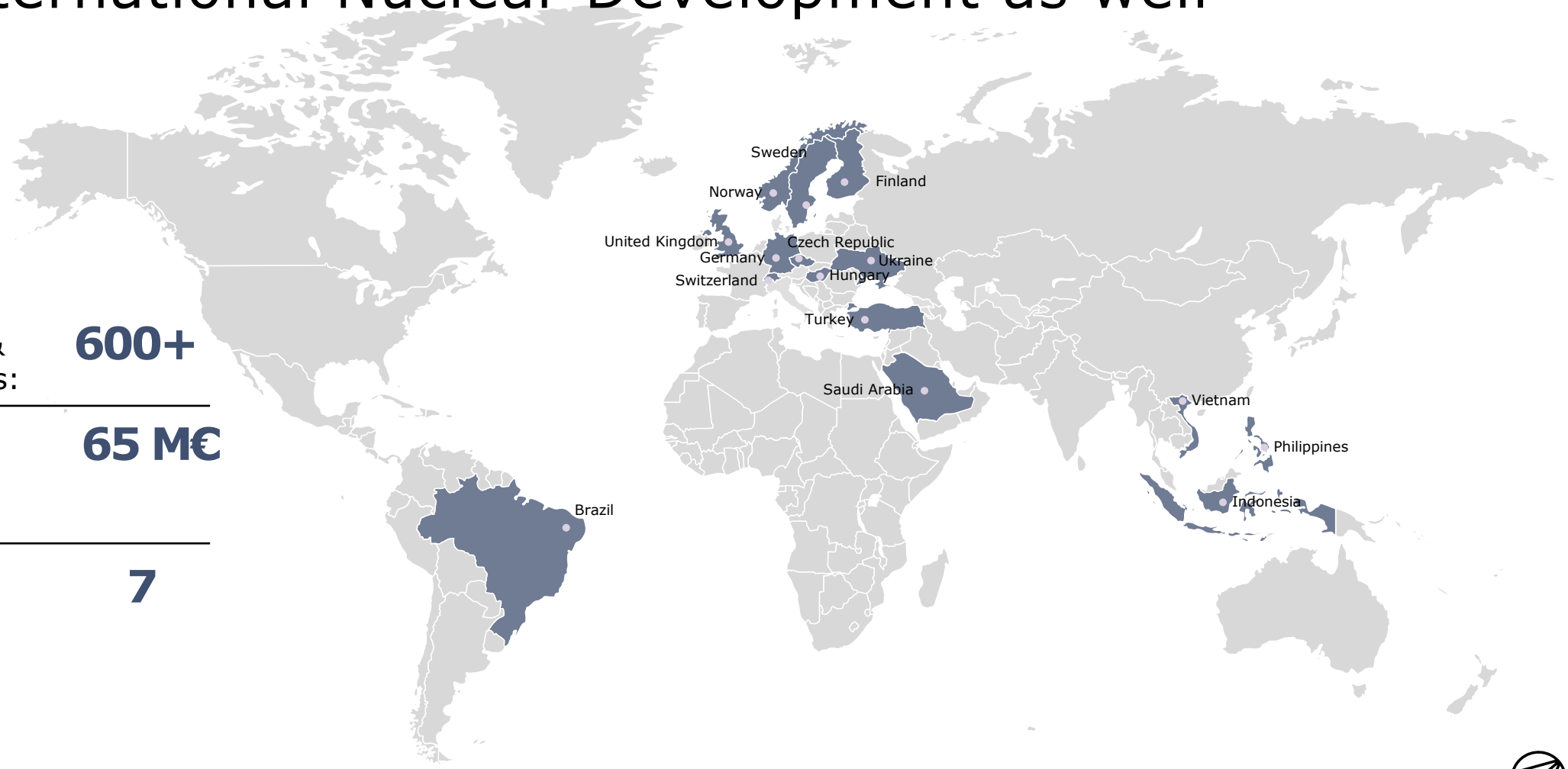
AFRY Intelligent Scenario Modelling

SYP2025

AFRY Nuclear mainly operates within Europe but drives International Nuclear Development as well



No. of experts & engineers:	**600+**
Approx. annual revenue:	**65 M€**
Offices in country:	**7**

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ÅF PÖYRY

AFRY Intelligent Scenario Modelling overview

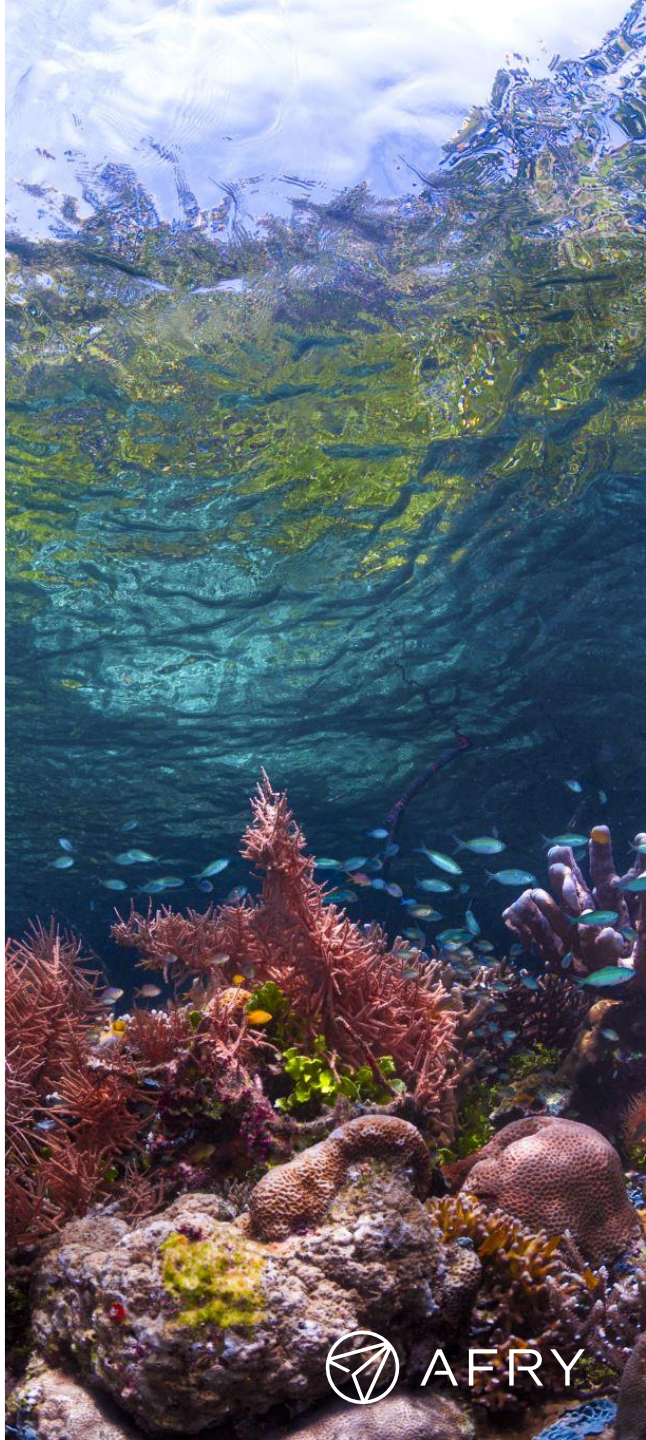
AFRY INTELLIGENT SCENARIO MODELLING

Overview

- Numerical simulations
- Risk assessments
- Sensitivity analysis
- Databases
- Documentation
- Reporting
- Quality assurance support

GOAL WHEN USING SOFTWARE

Create mathematical models of dynamic systems and simulate them



Applications

Radionuclide transport

Modelling the fate of radionuclides in a facility and environment

Pharmacokinetic Modelling

Prediction absorption, distribution, metabolism and excretion of substances in biota

Chemical exposure assessment

Models to assess the exposure to chemicals following releases to the environment

Carbon sequestration

Modelling the long-term behaviour of carbon after its sequestration

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EXAMPLE PROJECTS

Projects to be presented

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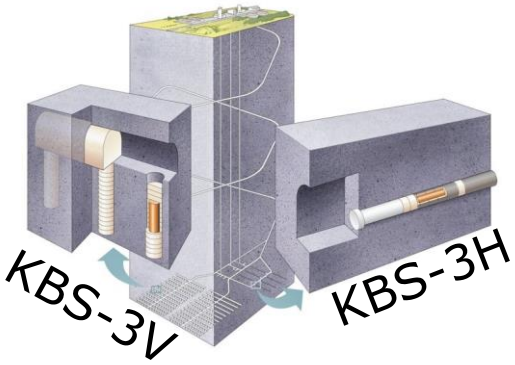
AISM through the nuclear lifecycle and beyond

ess EUROPEAN SPALLATION SOURCE

Risk assessment for license application

Dose estimation for operational nuclear station



Post closure safety for final repository

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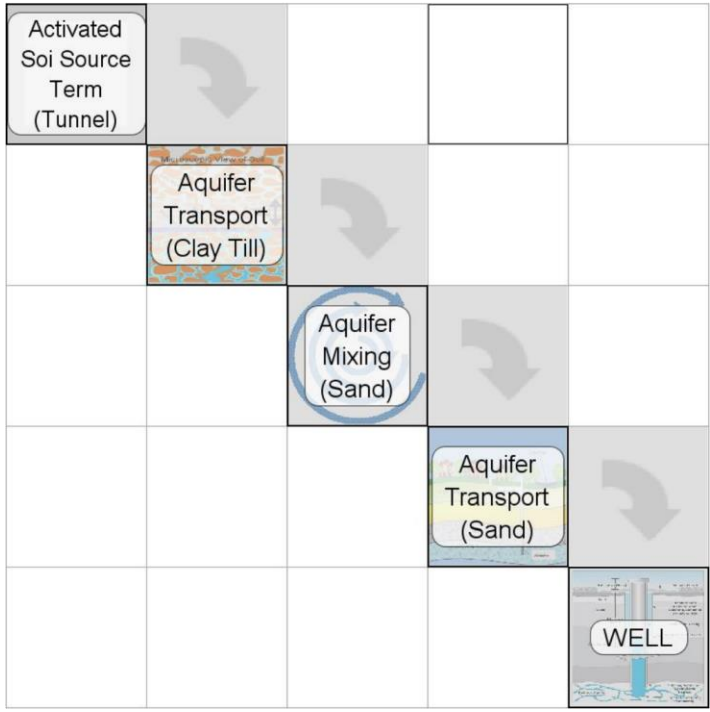
EXAMPLE PROJECT

Risk assessment for license application

- Environmental impact assessment (EIA) carried out in support for license application
- Radionuclide dispersion following releases during normal operation
- AISM used for:
  - Migration of radionuclides through all identified land types due to atmospheric deposition
  - Groundwater and aquatic transport of radionuclides
  - Dose calculations



Project challenges

- Large number of radionuclides
  - Built-in support for decay and ingrowth
  - Fast and efficient solvers
  - Screening
- Uncertainties in modelling assumptions
  - Uncertainty analysis
  - Sensitivity analysis
- Accurate modelling of calculation area
  - Modelling experience
  - Sensitivity analysis
- Regulatory framework
  - Knowledge of regulations
  - Approved/tested methodology

EXAMPLE PROJECT

Dose estimation for operational nuclear station

- PREdiction of DOses from normal releases of radionuclides to the environment.
- Tool for assessment of radiological consequences during normal operation of the Swedish nuclear facilities.
- Contains models for each facility in Sweden.
  - Site-specific parameters built-in.

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Project challenges

- Fast program that is easy to use
  - Possibility to use pre-calculated values
  - Training and support
- Software must reflect current requirements and sites
  - Constant development
  - PREDO coordination group
- Taking uncertainities into account
  - Pre-defined probabilistic parameters
  - Possibility to calculate probabilistic dose parameters
- Quality assurance
  - Backwards compability
  - QA processes

EXAMPLE PROJECTS

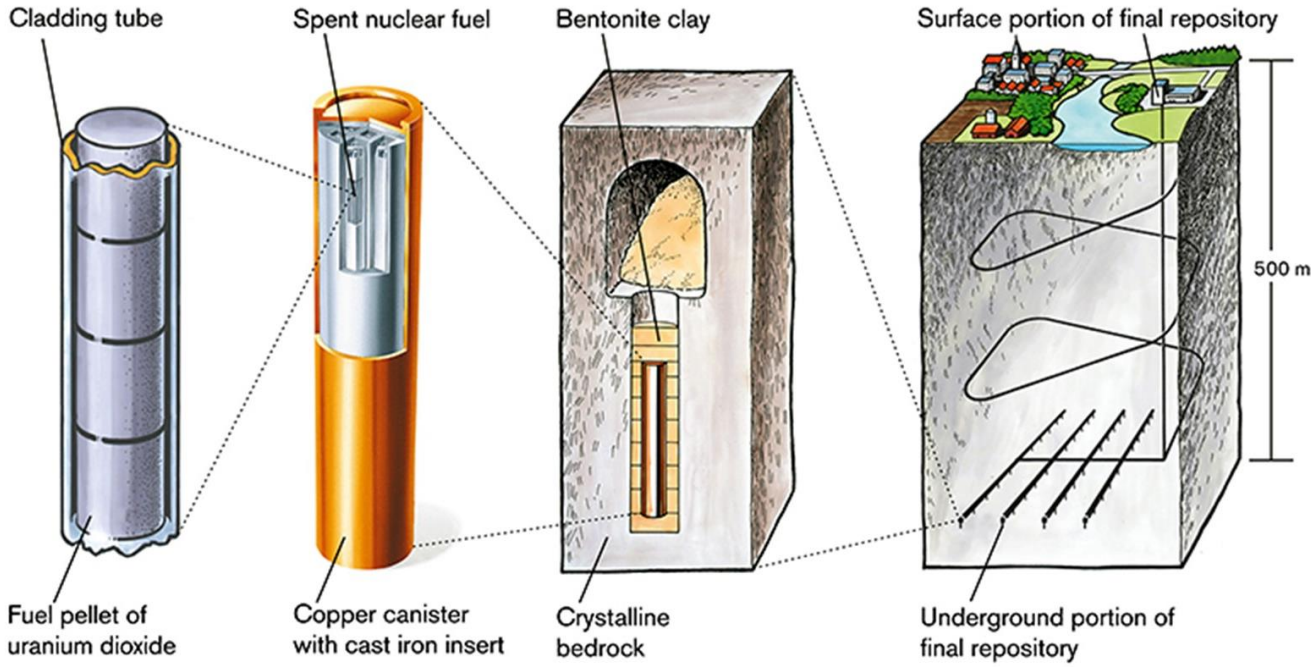
Post closure safety for final repository

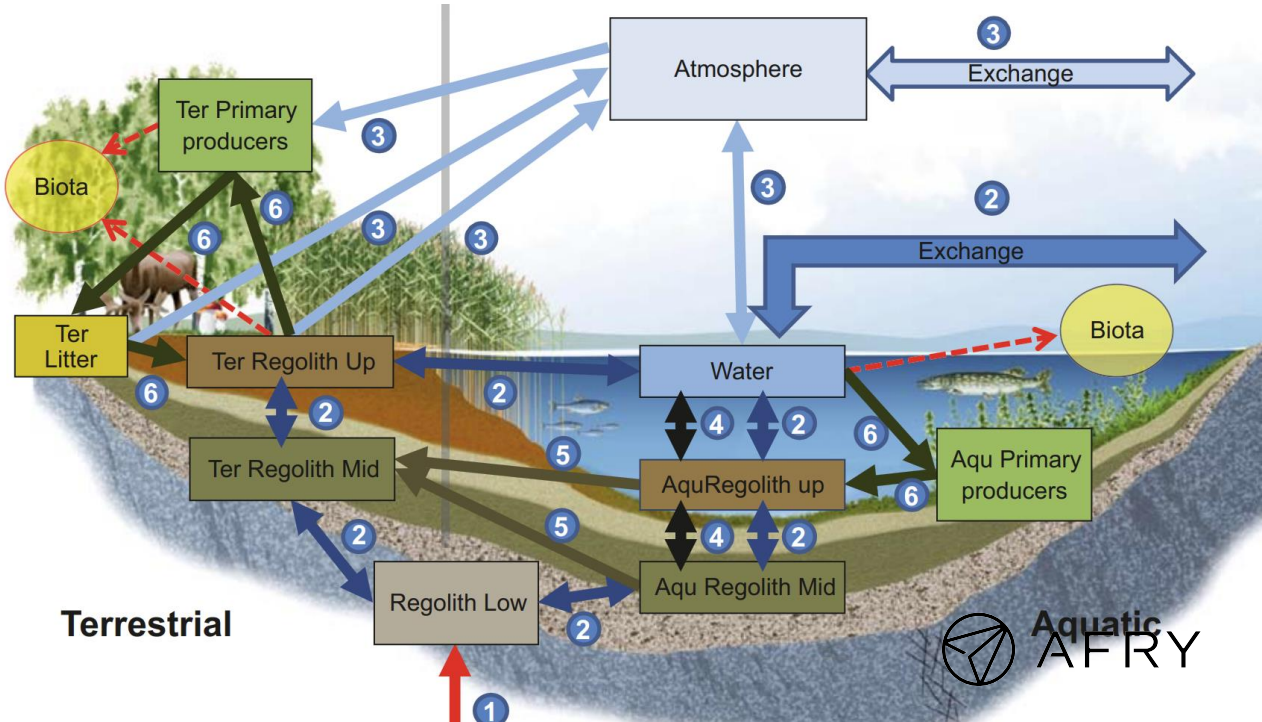
— Evaluation of long-term safety of repository in connection to application.

— Derivation of dose conversion factors for releases to the biosphere.

— Site-specific model taking long-term changes to geography into account.

— AISM used for probabilistic simulations.





Project challenges

- Changes to landscape during time-scale
  - Model the future based on the past
- Changes to food production during time-scale
  - Transformations of biosphere built into model
  - Choose limits relating to food production and diet
- Source term uncertainties
  - Division of source term into constant release and sudden release
- System uncertainties
  - Evaluate using different assumptions
- Parameter uncertainties
  - Probabilistic simulations

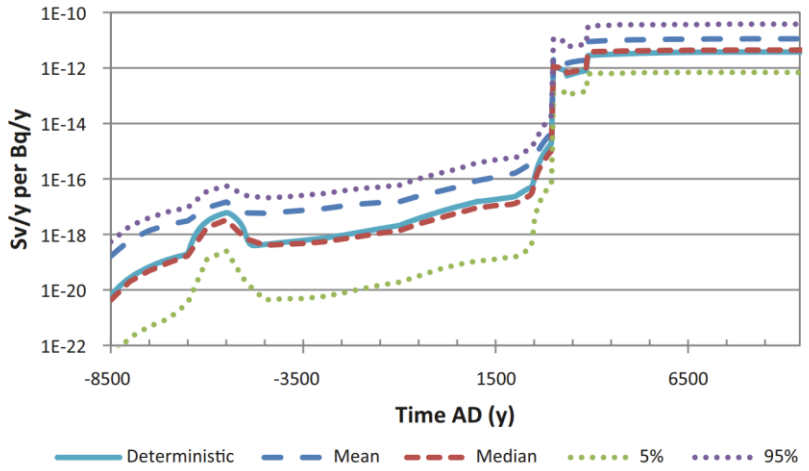
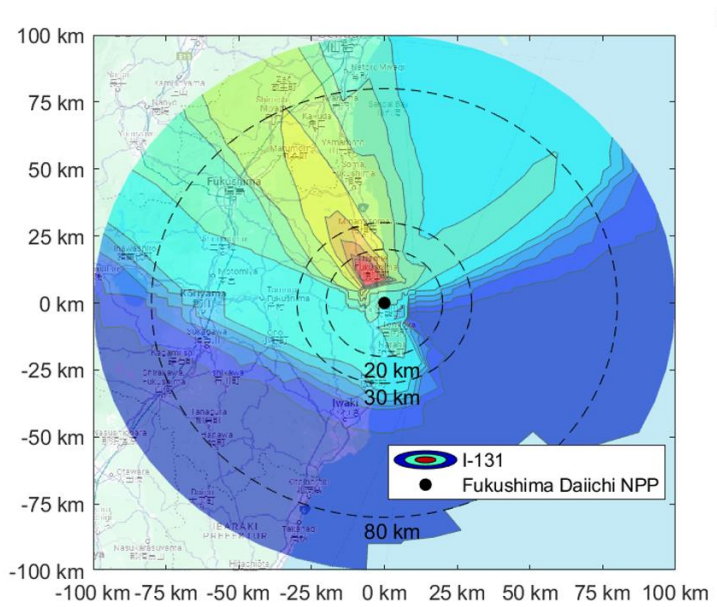


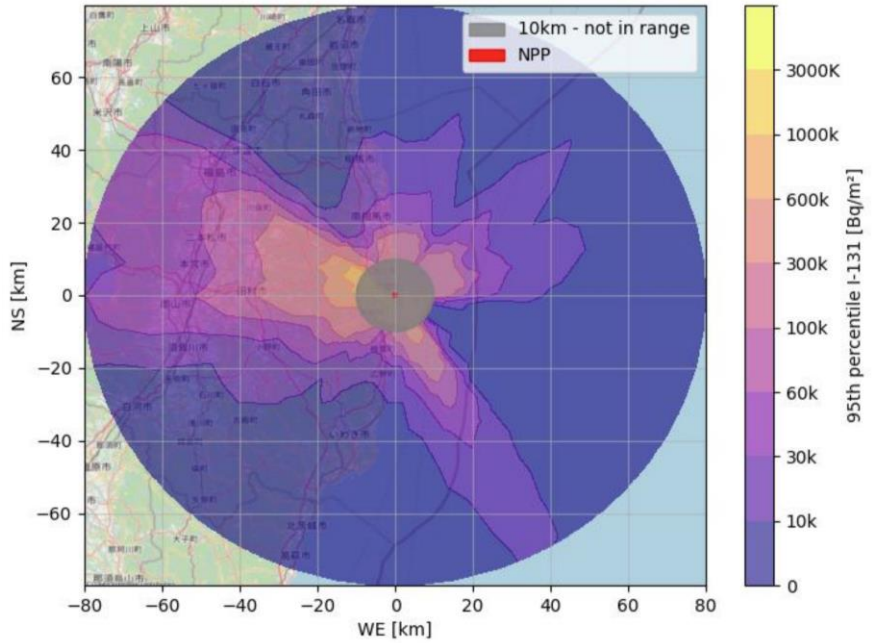
Figure 5-36. *Evolution of the LDF in time for Ra-226, showing the effect of uncertain parameters. The deterministic LDF values are also shown for comparison.*

EXAMPLE PROJECTS

Master theses – Level 3 PSA

- Theses investigation into the possible application of AISM in level 3 PSA
- Initial thesis [1]
  - Implemented air dispersion model
  - Highlighted need for more advanced model
- Second thesis [2]
  - Implementation and validation of air dispersion model
  - Less focus on probabilistic part
- Third thesis [3]
  - Further validation efforts of air dispersion model
  - Focused on probabilistic results





[1] O. Winestedt, ”Validering av Ecolego för modellering i enlighet med PSA nivå 3: Beräkning av markdeposition och radionuklider vid fiktiv svår härdskada vid Forsmarks kärnkraftverk”, 2022
[2] T.Lindberg, ”Is AFRY Intelligent Scenario Modelling suited to be used for modelling in a level 3 PSA”, 2024.
[3] A. H. Totar Villar, ”Modeling weather dependent radionuclide deposition for Level 3 PSA”, 2025.

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Conclusion

- Used in all stages of the nuclear lifecycle and beyond
  - License application
  - Operational nuclear plants
  - Post closure safety for repositories
- Developed for radiological risk assessments which means support for
  - Radionuclide deacy and ingrowth
  - Probabilistic simulations
  - Sensitivity analysis

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Making Future
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