UNIVERSITY OF GOTHENBURG

LARCalc:

An easy-to-use tool to estimate radiation dose and risk from large scale nuclear power plant fallout using ^{137}Cs as a key nuclide

Jonathan Sundström
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LARCalc, a tool to estimate sex and age specific lifetime attributable risk in populations after nuclear power plant fallout

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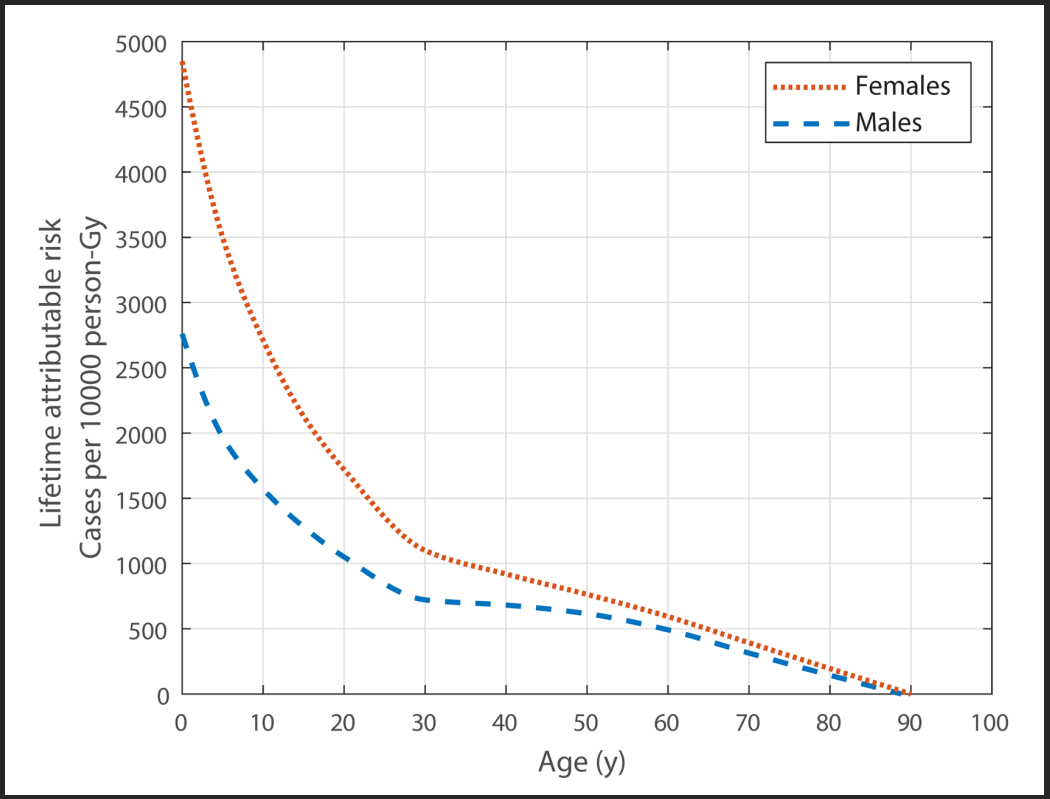
Abstract.
A tool called LARCalc, for calculating the radiological consequences of accidental nuclear power plant releases based on estimates of ^{137}Cs ground deposition, is presented. LARCalc is based on a previously developed models that has been further developed and packaged into an easy-to-use decision support tool for training of decision makers. The software visualises the radiological impact of accidental nuclear power plant releases and the effects of various protective measures. It is thus intended as a rapid alternative for planning protective measures in emergency preparedness management. The tool predicts projected cumulative effective dose, projected lifetime attributable cancer risk, and residual dose for some default accidental release scenarios. Furthermore, it can predict the residual dose and avertable cumulative LAR resulting from various protective measures such as evacuation and decontamination. It can also be used to predict the avertable collective dose and the increase in cancer incidence within the specified population. This study presents the theoretical models and updates to the previous models, and examples of different nuclear fallout scenarios and subsequent protective actions to illustrate the potential use of LARCalc.

Keywords: cumulative effective dose, cumulative lifetime attributable risk, atmospheric fallout, NPP release, protective measures

Submitted manuscript to Scientific Reports

What is LAR

- LAR - Lifetime Attributable Risk
  - Cancer risk from a one-time low dose exposure
  - Defined for 15 types of cancer
  - Age- and sex-dependent
    - Unlike effective dose
- Cumulative LAR, $CUMLAR$
  - Continuous exposure



Curve fit of LAR for 15 cancers
Data from U.S. Environmental Protection Agency
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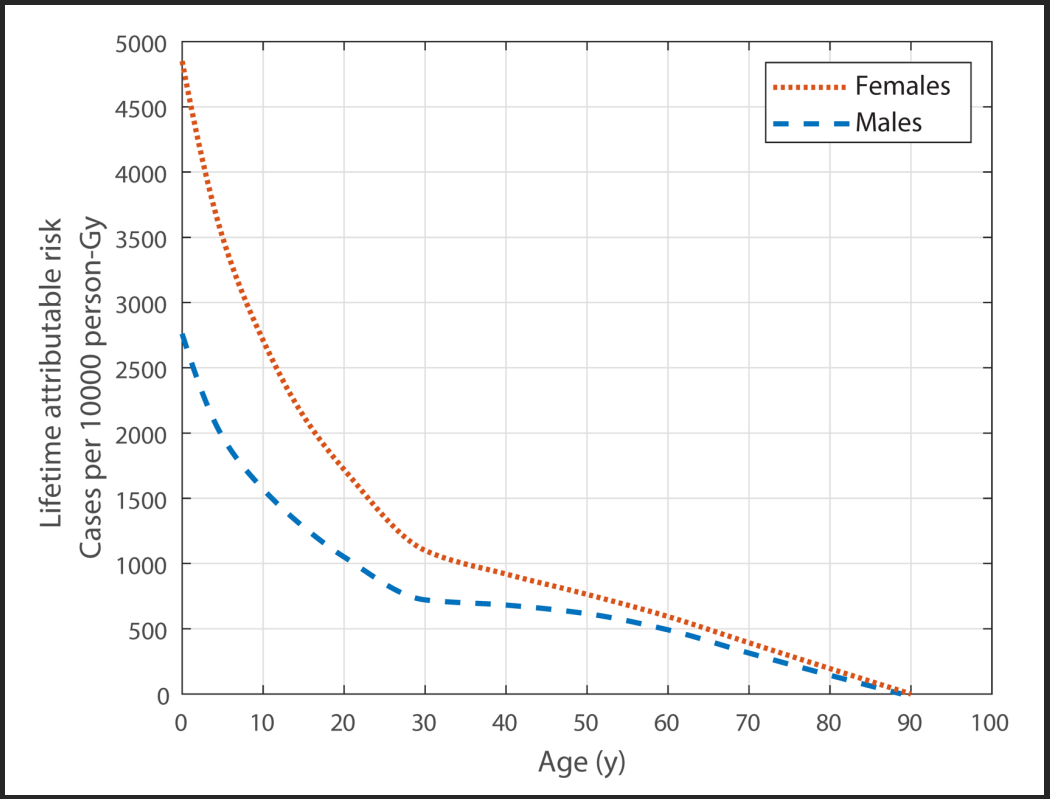

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  - .exe through Runtime
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- Fallout scenarios
  - ^{137}Cs + Nuclide vector
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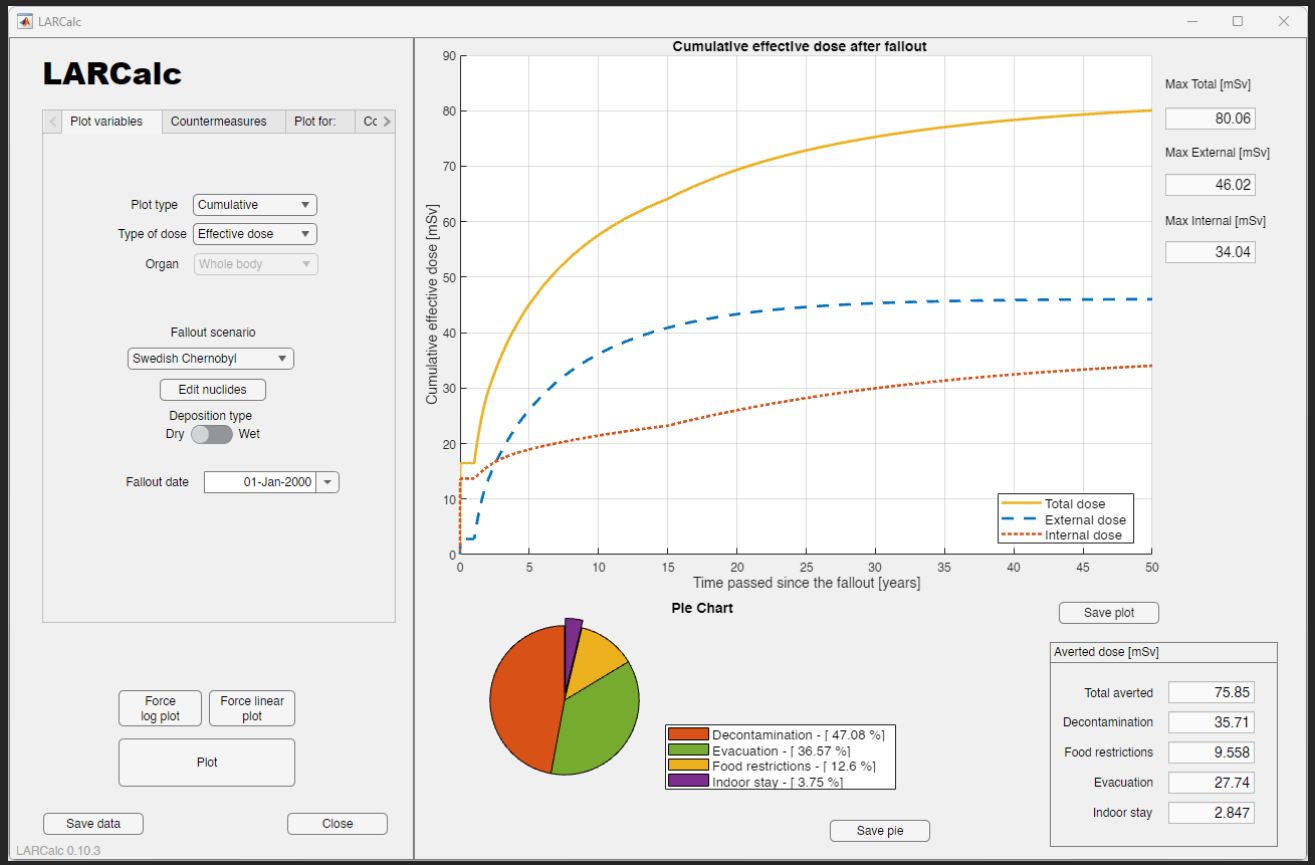

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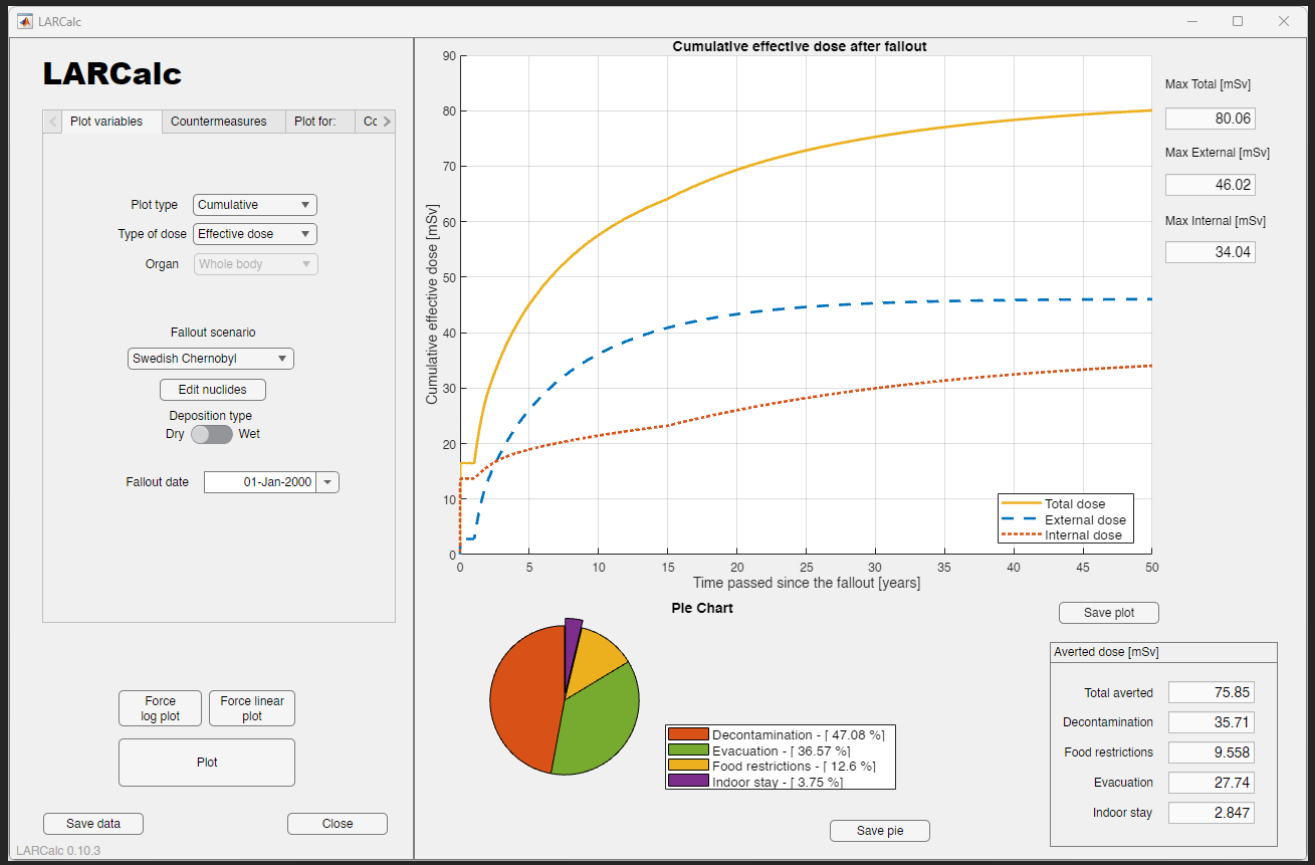

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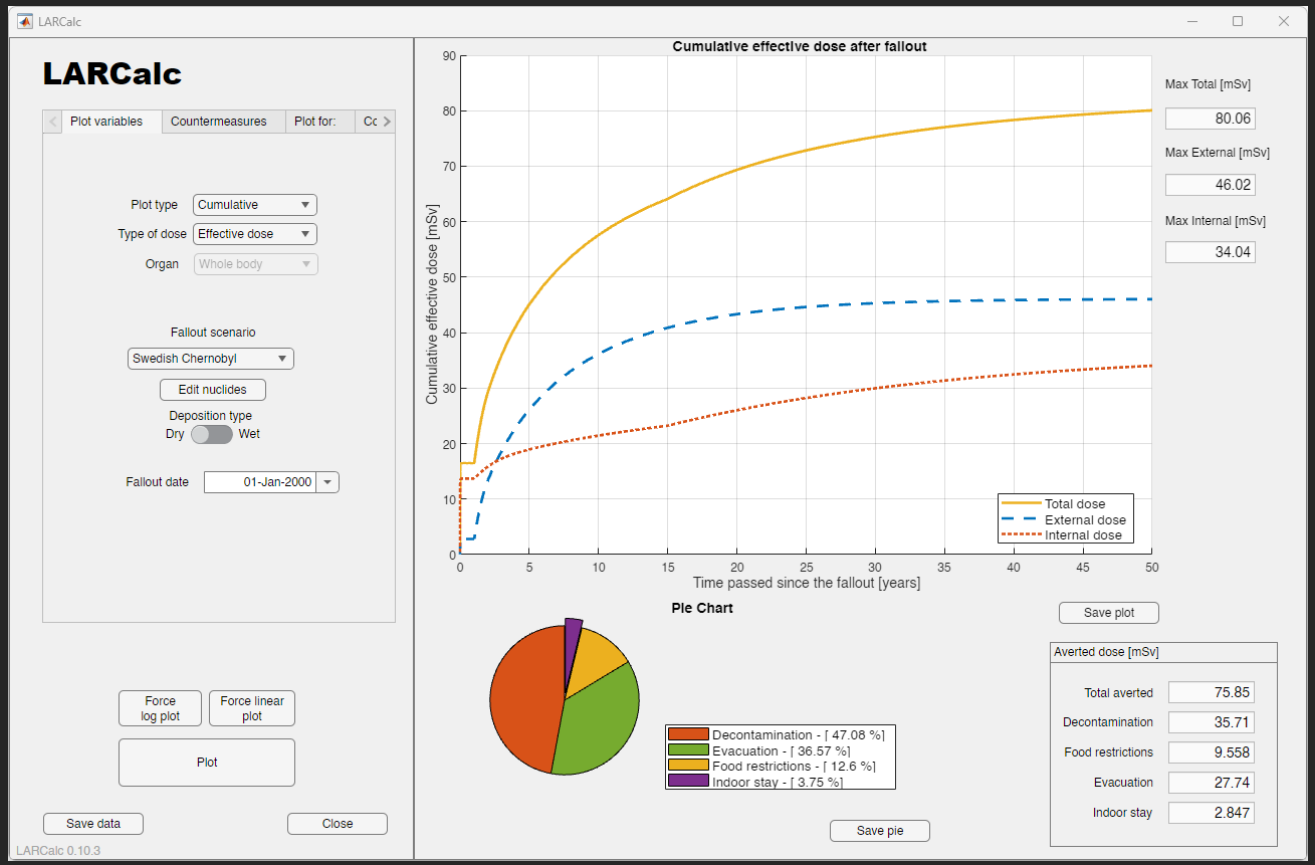

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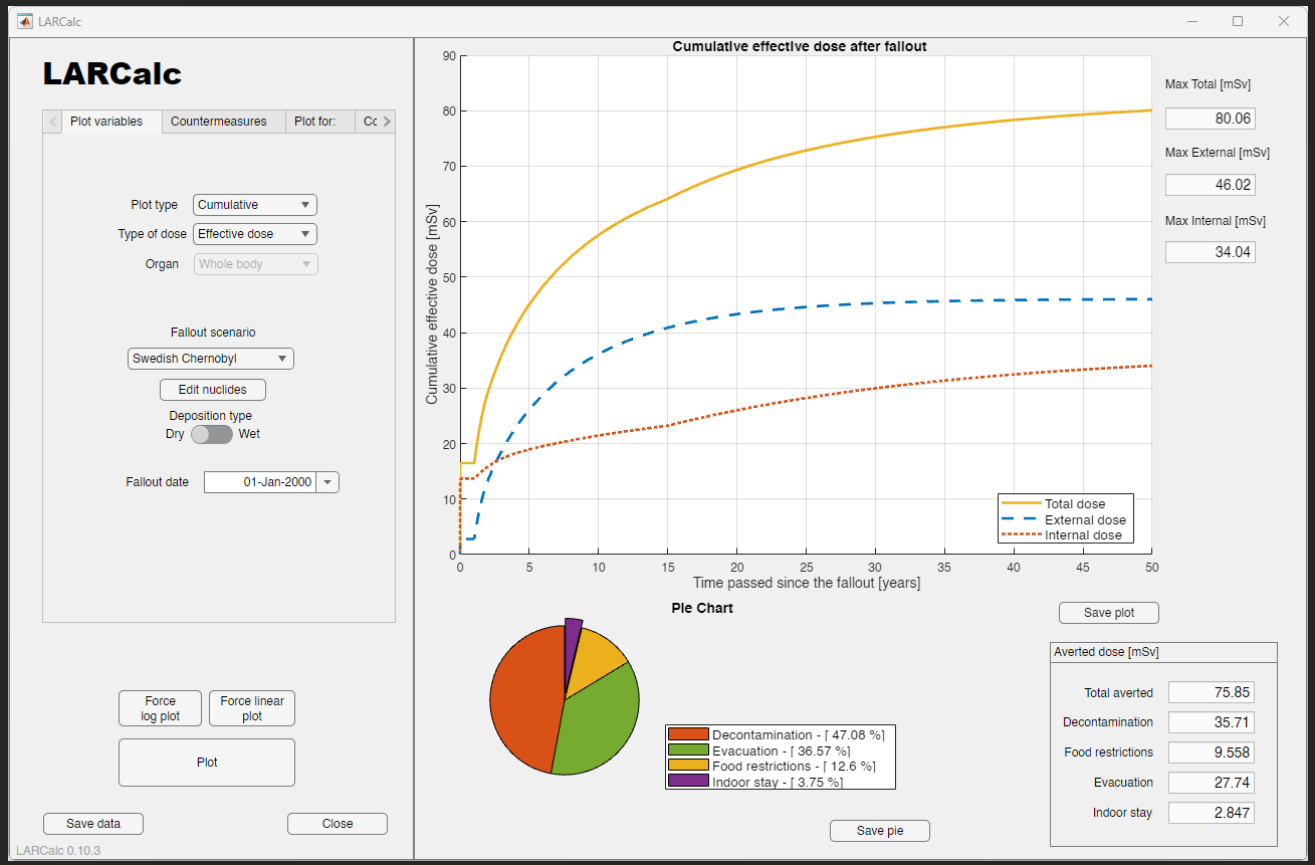
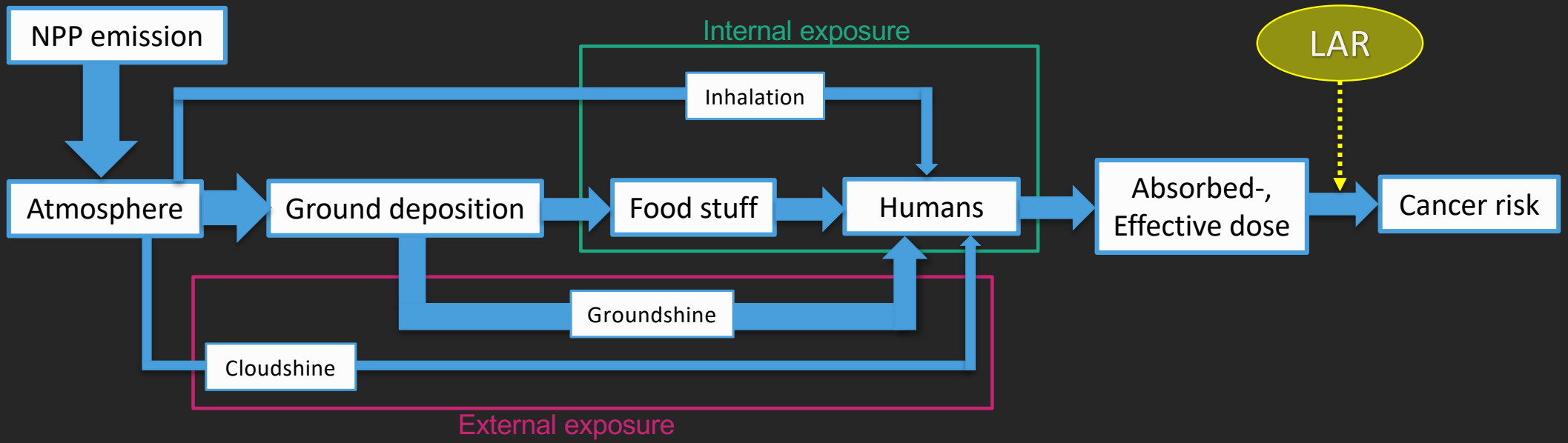


Overview of the LARCalc sub-models



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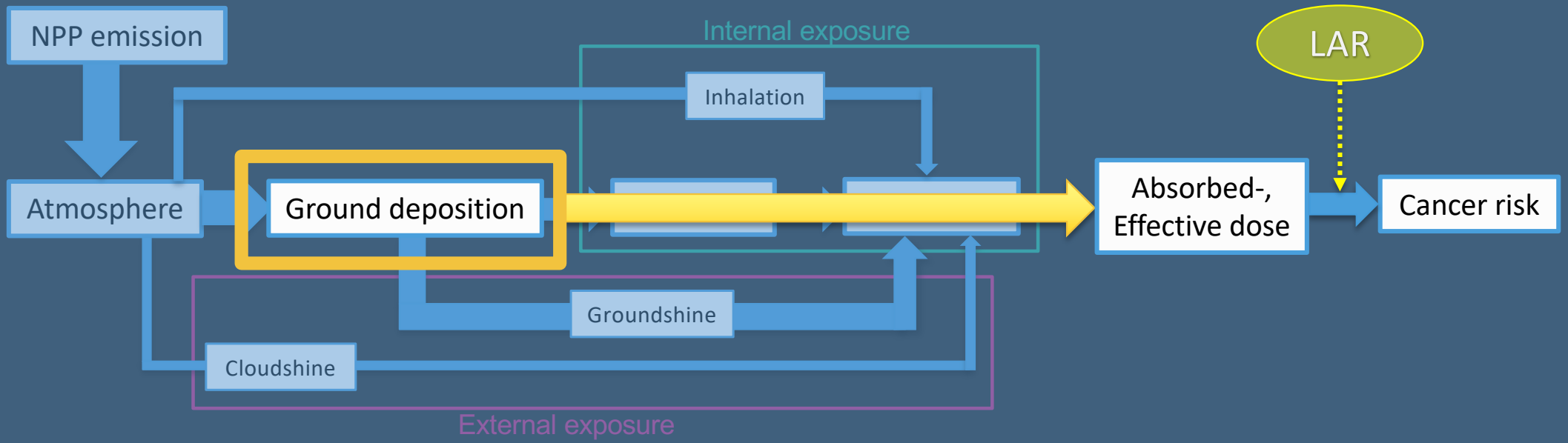

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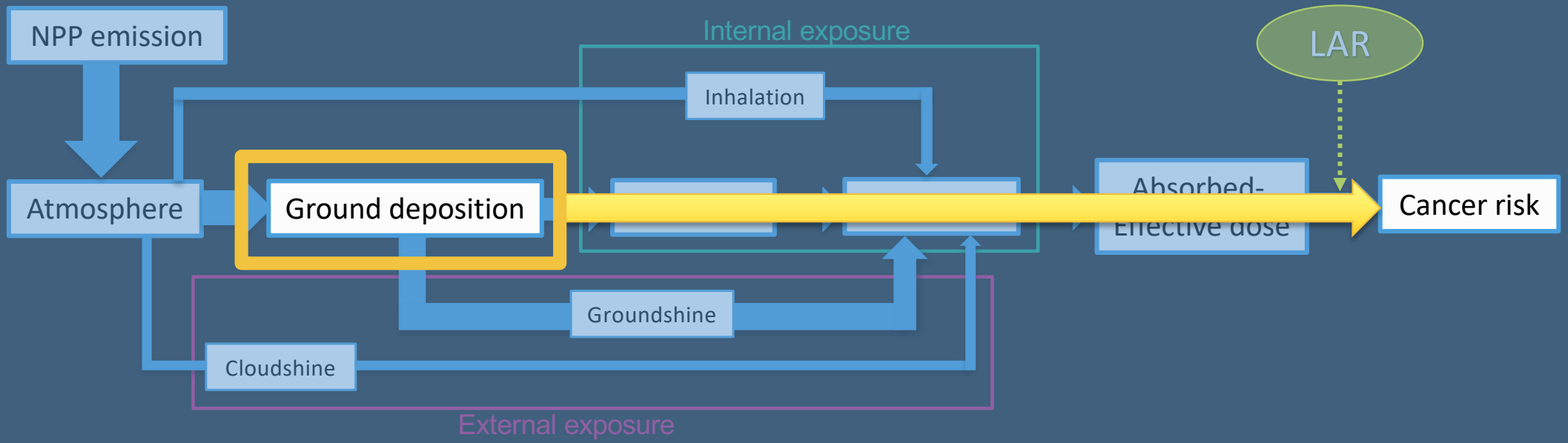

Countermeasures

- Indoor stay
  - Reduces inhalation dose and external exposure
- Evacuation
  - Eliminates all exposure
- Food restrictions
  - Reduces dose from ingested Cs, Sr and I
- Decontamination
  - Reduces future dose from external exposure

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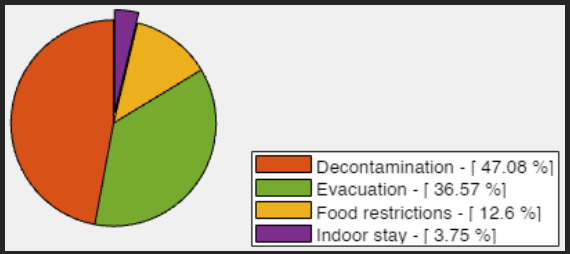
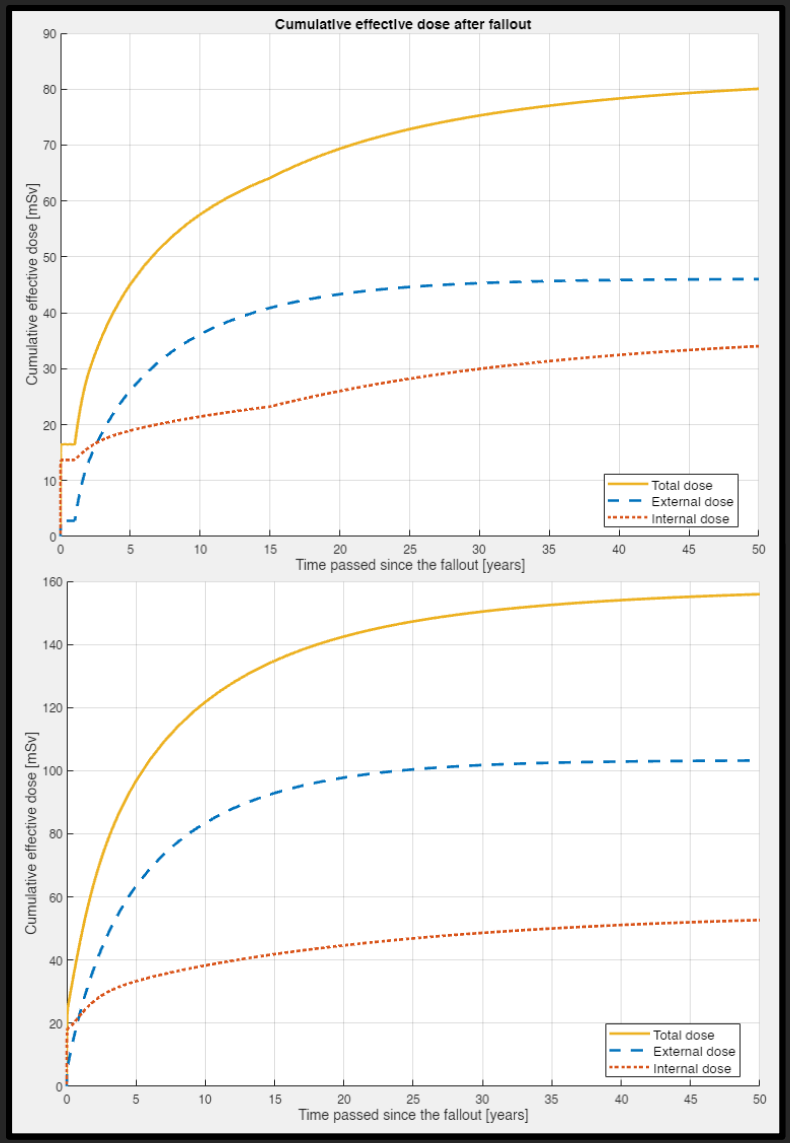
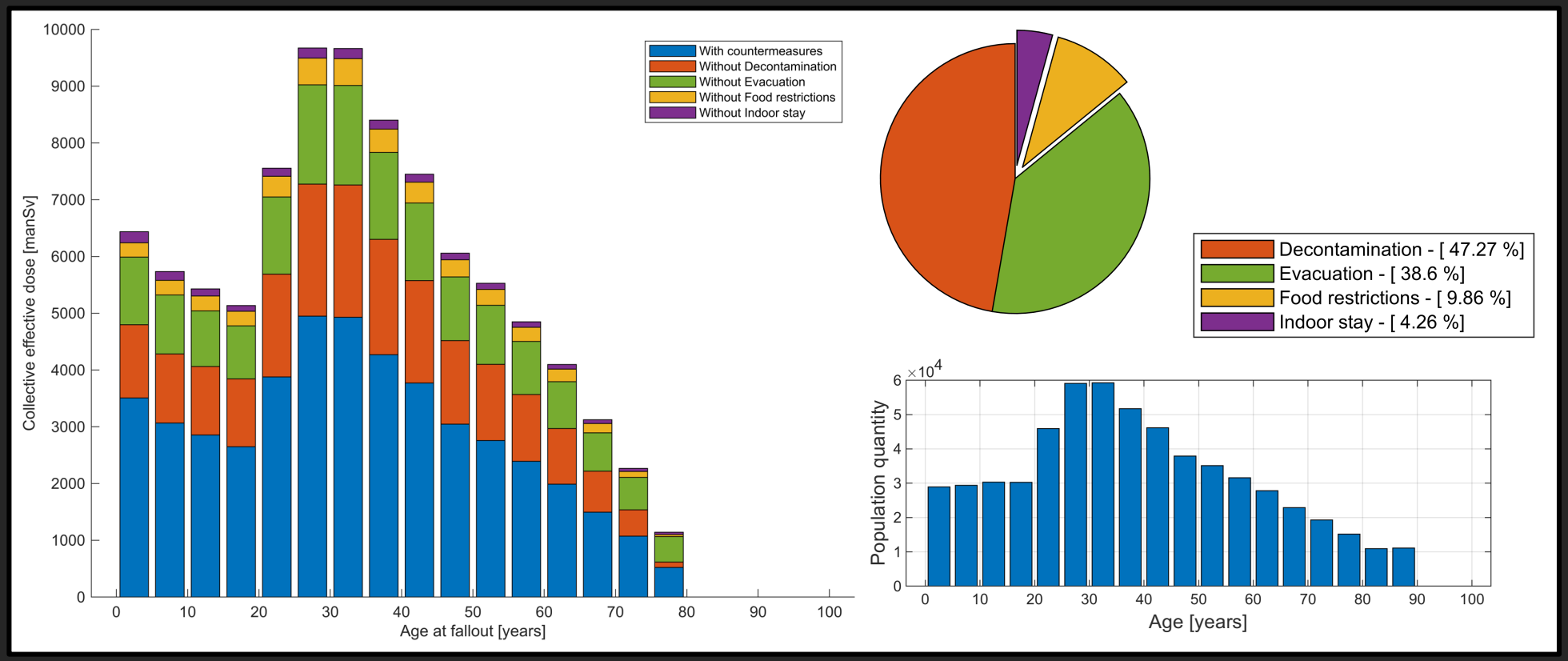


- Indoor stay 7 days
  - Reduces inhalation dose and external exposure
- Evacuation 1 year
  - Eliminates all exposure
- Food restrictions 50 %, 15 years
  - Reduces dose from ingested Cs, Sr and I
- Decontamination 50 %, after evacuation
  - Reduces future dose from external exposure



Examples for the population in Dublin (Total 592 713)



The Chernobyl fallout normalized to 1 MBq/m^2 (^{137}Cs) and previously mentioned countermeasures

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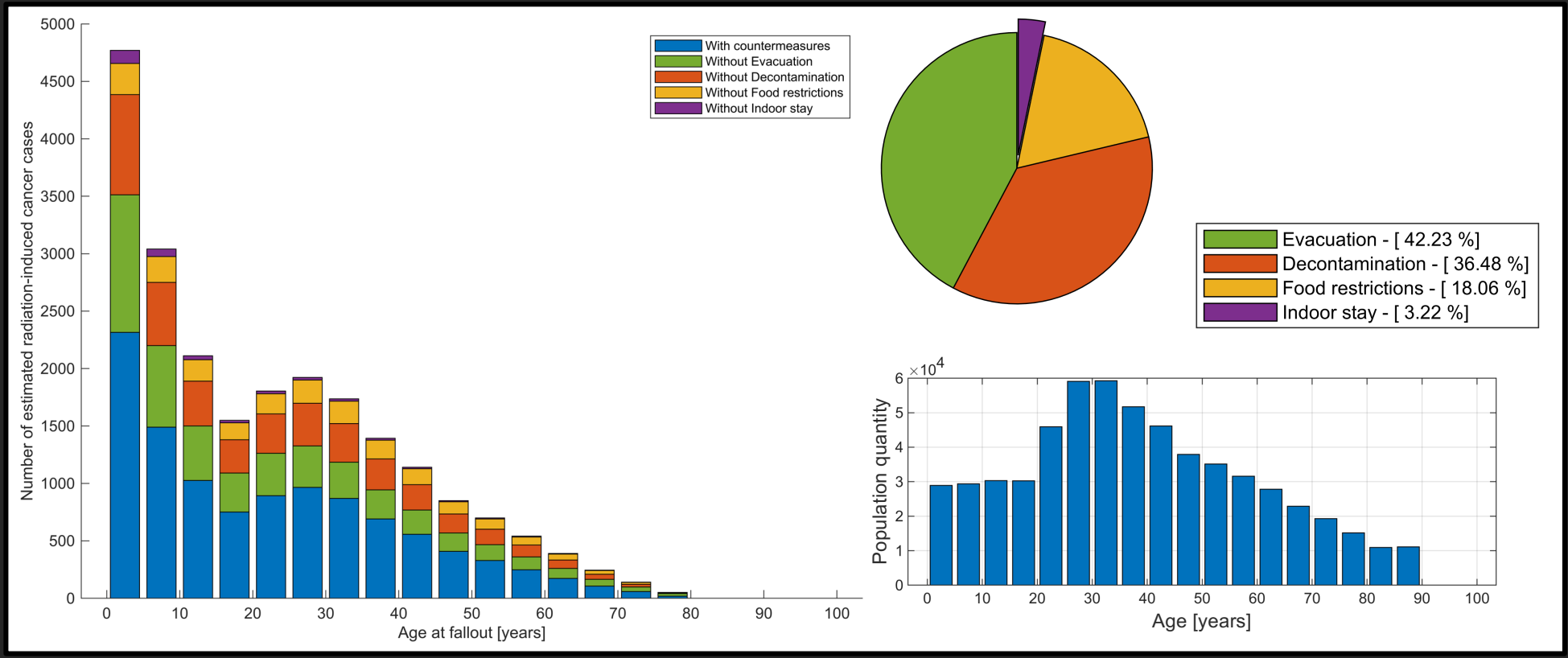

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Compared to COSYMA

- A similar tool from the 90s
  - 0.4x – 4.6x COSYMA
  - Suspects uncertainties
- ICRP 144
  - Only physical and biological decay
  - 84,5 mSv/(MBq m^{-2}) ^{137}Cs

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Internal effective dose	12.4	23.4	81	32.7
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- 50 000 iterations
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- Median 225.8 mSv
- 5th percentile 118.8 mSv
- 95th percentile 429.5 mSv

- Overall uncertainty
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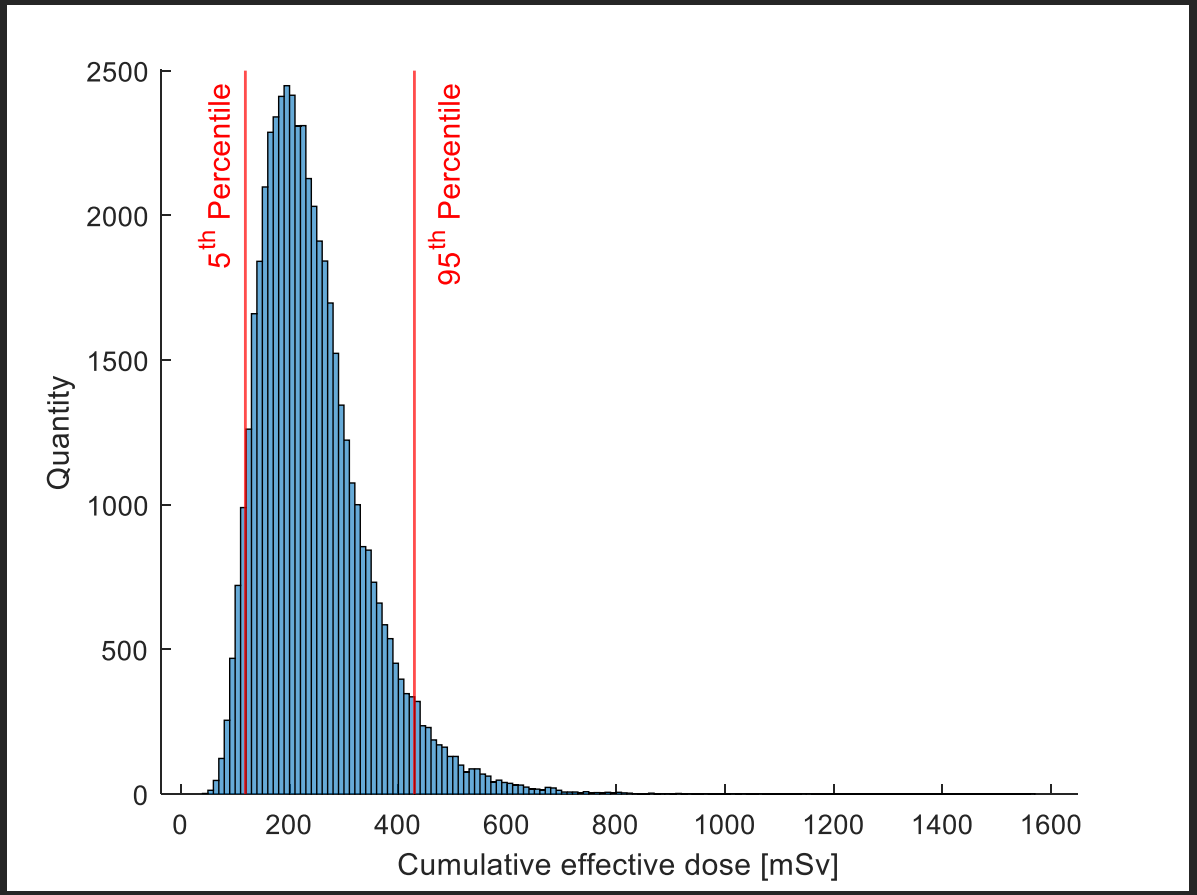

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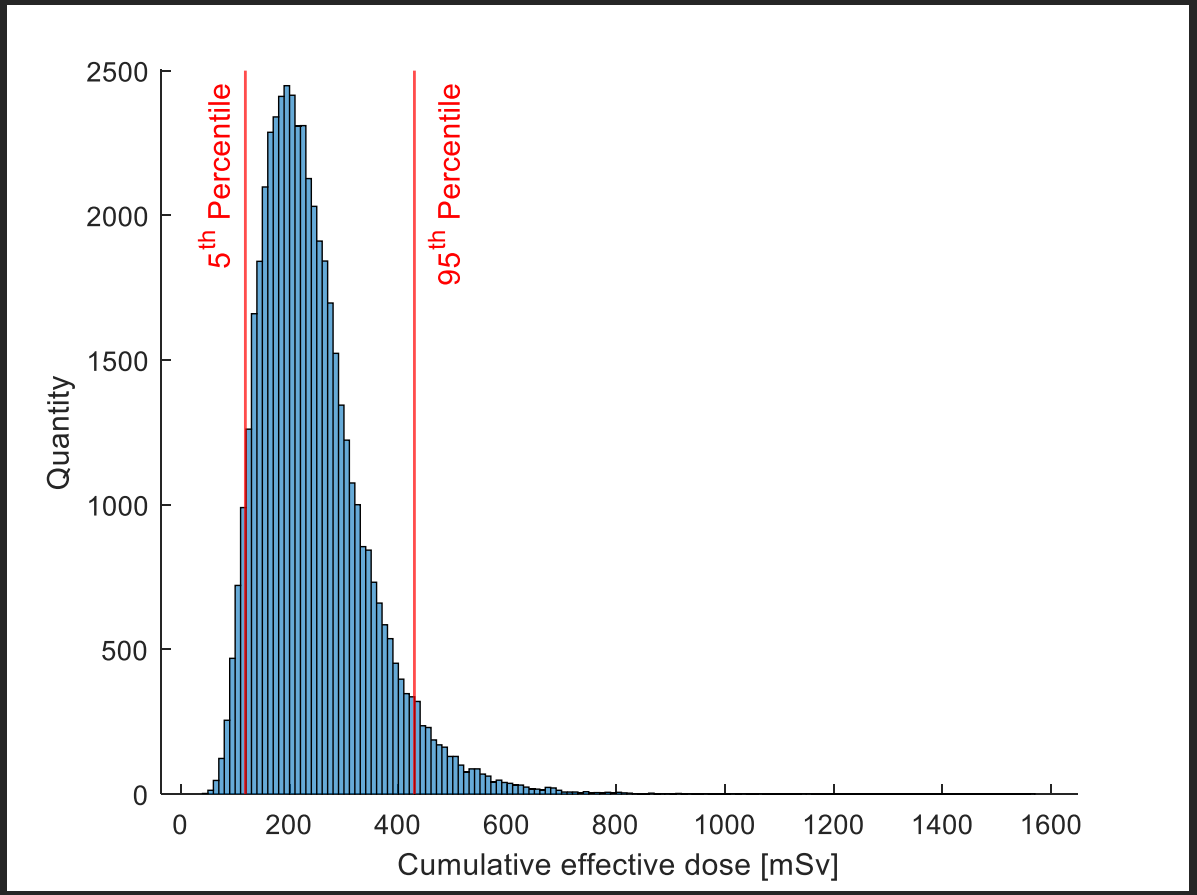

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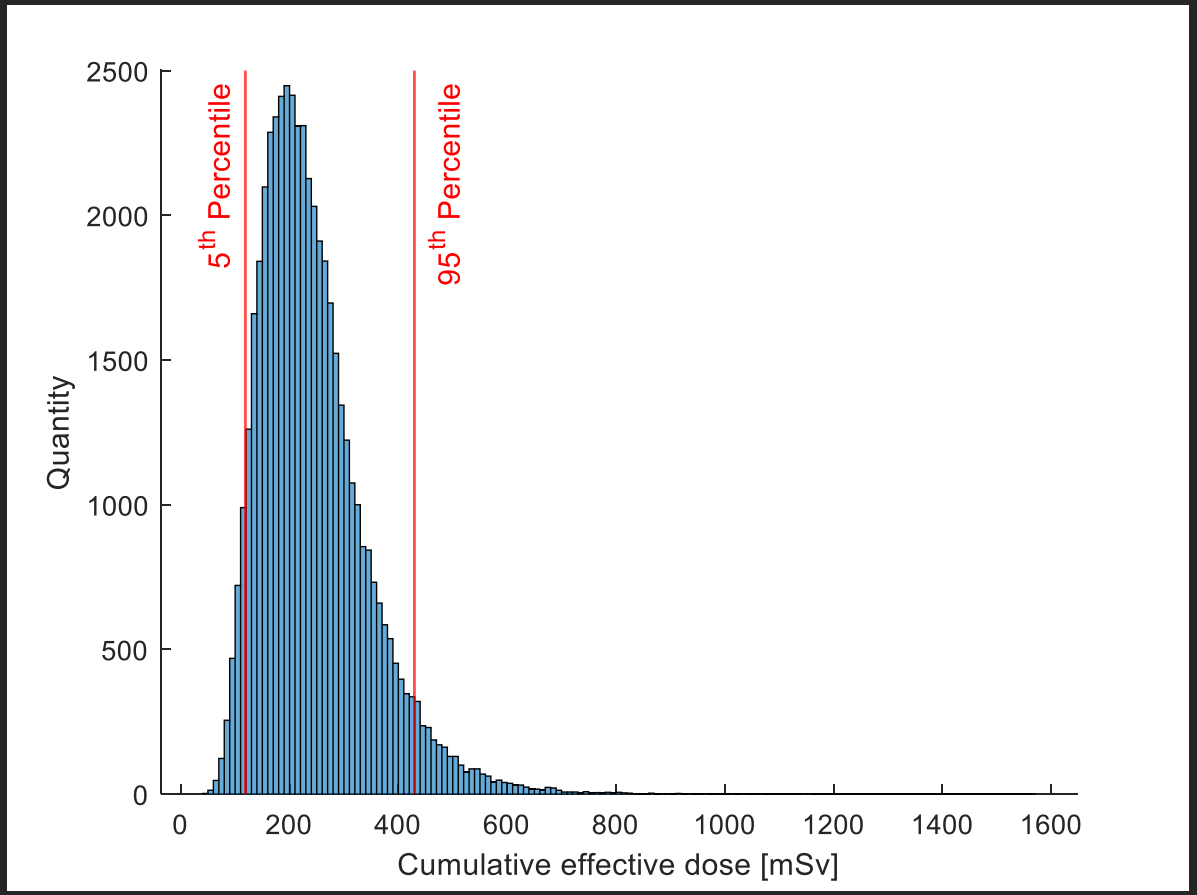

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- Age-, sex-, and organ-specific
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  - Local and regional ^{137}Cs deposition
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Special thanks to

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Thank you for your time!

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