Karlsruhe Institute of Technology

ICRP-103 Screening Tool

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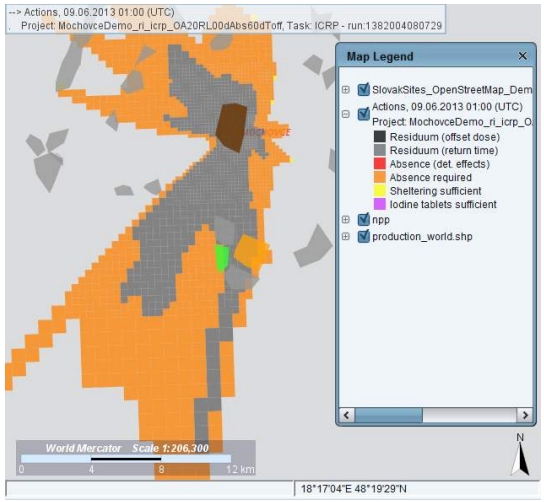
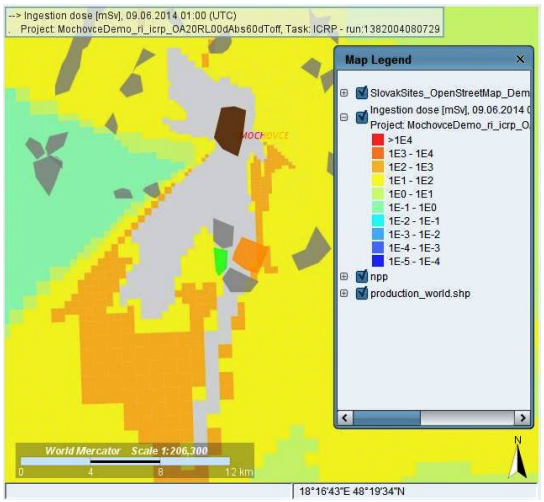




Starting point for development

- Spring 2011: NERIS-TP demands development of a tool for considering the new ICRP-103 recommendations
- 2012/2013 Design of model and user interface; realization in the JRodos System under the model name "ICRP".
- The ICRP Screening Tool fulfils **three main requirements:**
  - Takes into account all terrestrial exposure pathways, including ingestion
  - Considers sheltering, evacuation, relocation, food restrictions, and the use of iodine tablets for thyroid blocking, for reducing or avoiding doses
  - Identifies an action set for limiting the total effective equivalent dose received from all pathways over a given time period, the "criterion dose", below a given reference level

Criterion Dose (CD)

- **Model Step 1: Calculate key quantity "Criterion Dose" CD**

CD_{adults} (grid cell, no action) =

effective equivalent dose from cloud γ exposure *

+ effective equivalent dose from ground γ exposure* in 1st year

+ effective equivalent dose, committed, by inhalation from the cloud*

+ effective equivalent dose, from ingestion of selected foodstuffs, 1st year (marketable foodstuffs only)

*** {open air / normal living}, user selectable**

- Resuspension component - significant only for very specific scenarios; underlying model data mainly for cesium *(currently not included in code)*
- Skin component - significant only for very specific scenarios; difficult due to exposure duration *(currently excluded from CD)*

Sheltering-Evacuation-Relocation+Iodine/ingestion Area of Interest

- **Model Step 2: Determine S-E-R+I Area of Interest (AoI)**
  - Cells where **CD_{adults} (grid cell, no action)** exceeds the reference level → **general 'S-E-R+I' tag**
  - Cells where "open air" exposure may potentially lead to (severe) **deterministic health effects → 'DET' tag**
    - *Model implemented in JRodos uses threshold levels on whole body and individual organs/tissue doses from a 2 days exposure*
    - *Model was created in 2010 for RODOS(Unix) implementation in Russia and bases on Russian specifications; they correspond well with the ones of ICRP 40, p. 12-14, § (A1) to (A12), but do not agree in all details*
    - *Several approximations due to lack of basic data, for example use of Equivalent dose - Sv - as substitute for absorbed dose - Gy*

One set of S-E-R+I actions leading to CD < RL

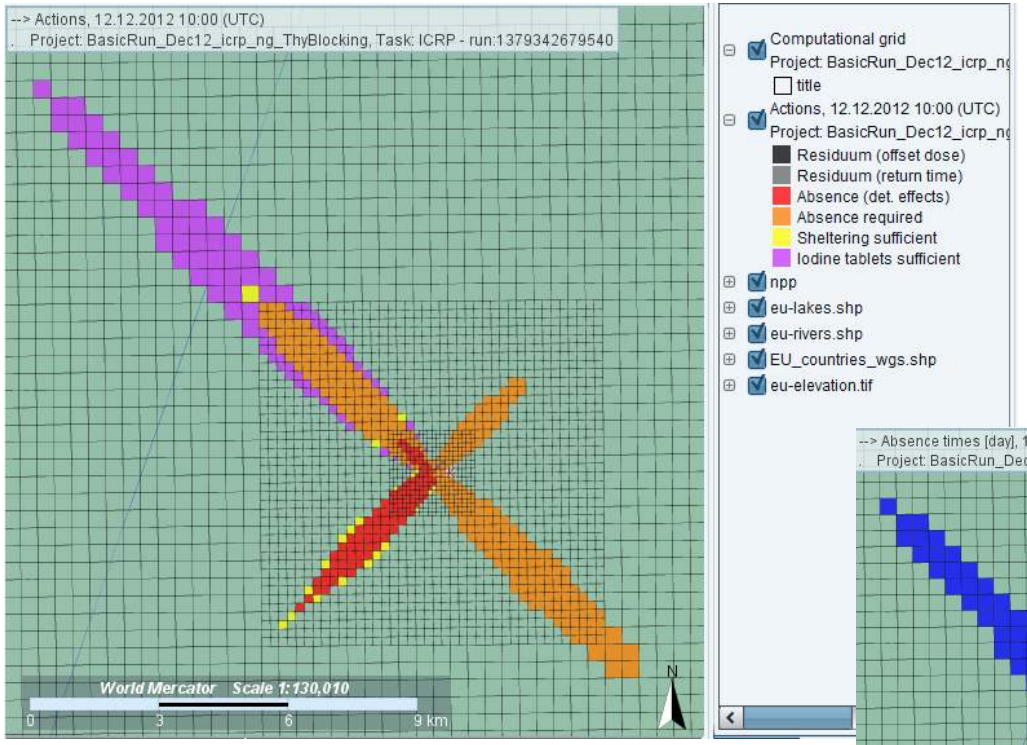
- **Model Step 3**: In each grid cell of the AoI, find a set of S-E-R+I actions that brings CD below RL
  - Action test sequence is (a) thyroid blocking* (if to be considered as an option) - (b) sheltering (if to be considered as an option) - (c) actions involving absence from the grid cell for a while (evacuation/ relocation); eventually preceded by sheltering (user selectable)
  - Exception: In cells with 'DET' tag, "absence" is always considered as the only option
  - Beginning with the lowest available action, check if action gets CD below Reference Level, If yes, problem is assumed to be solved and the next grid cell is analysed. If not, take next action - if available, else declare problem unsolvable in this way (cell becomes "Residuum" area, subject for e.g. ERMIN)

** 100% efficiency is assumed; reduction of CD is calculated (see publication)*

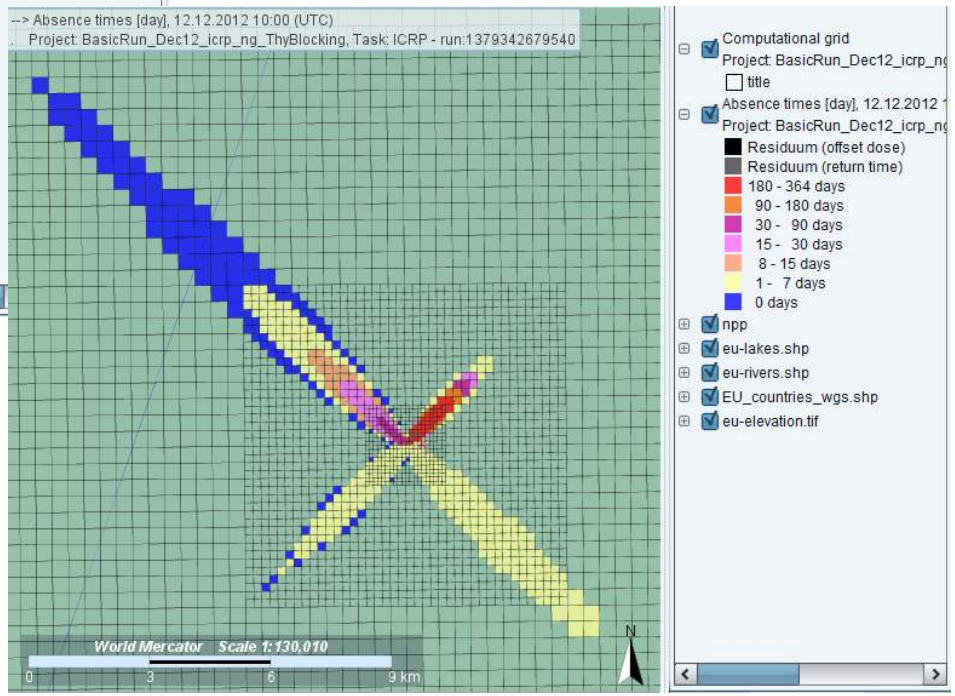
One set of S-E-R+I actions leading to CD < RL

- **Model Step 3** *(continuation)*
  - The start time for the successive checking of the actions is some given day after the beginning of the scenario; this **"action sequence start time"** can be specified by the user location-dependent on the map
  - Default is 0 days everywhere on the calculation grid
  - Quantity "action sequence start time" is useful for accounting in a location-dependent way for
    - Doses that were received at some point in time and cannot be mitigated by any action thereafter (the non-avertable dose pedestal)
    - Optimal starting time for sheltering - the max. shelter duration is only 24 or 48 hours (optional), unsuitable starting time can lead to zero efficiency

Main results of S-E-R+I screening analysis



Left: The set of actions that makes CD < RL identified in model step 3



Right: Absence times from area associated with above action set

Two approaches for the ingestion pathways

- **Approach IG1:** Component of Criterion Dose (CD) => S-E-R+I screening <=> included in model steps 1, 2, 3

  Suitable for locally produced marketable foodstuffs consumed by average local consumers

  Marketable foodstuffs <=> contaminated below the ECs maximum permitted levels of radioactive contamination of food stuffs and of feeding stuffs ("CFILs")

  User can choose whether or not to include such component(s) in the CD, and for which foodstuffs

Ingestion pathways *(continuation)*

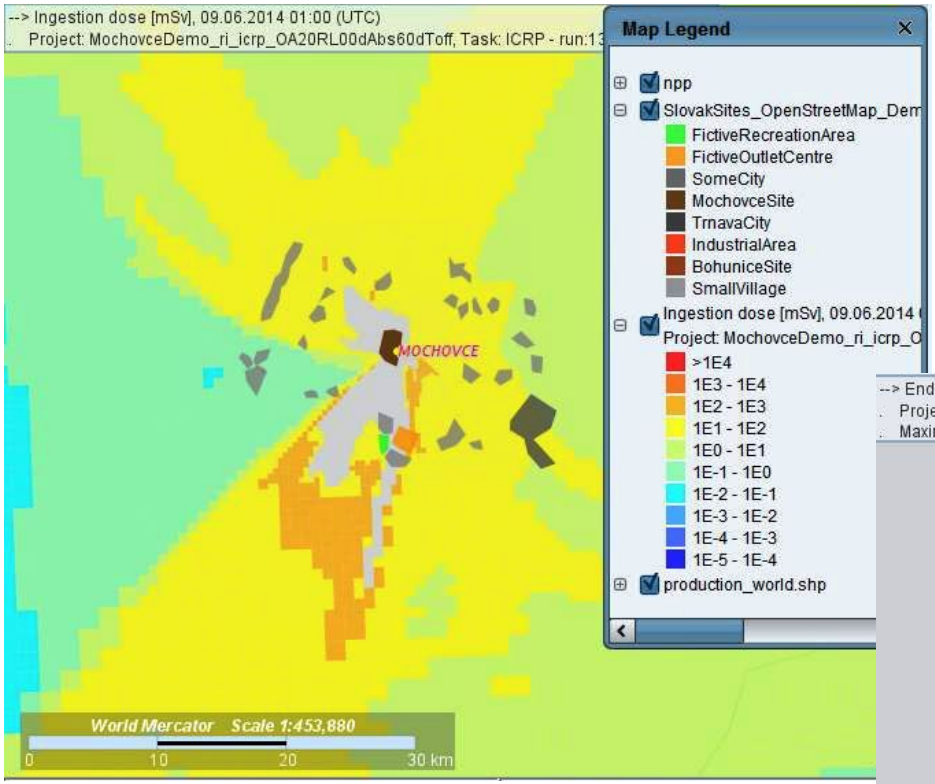
- **Approach IG2:** Comparison of ingestion doses with the Criterion Dose Remainder (CDR) from S-E-R+I screening step

CDR (grid cell) = Value of Reference Level

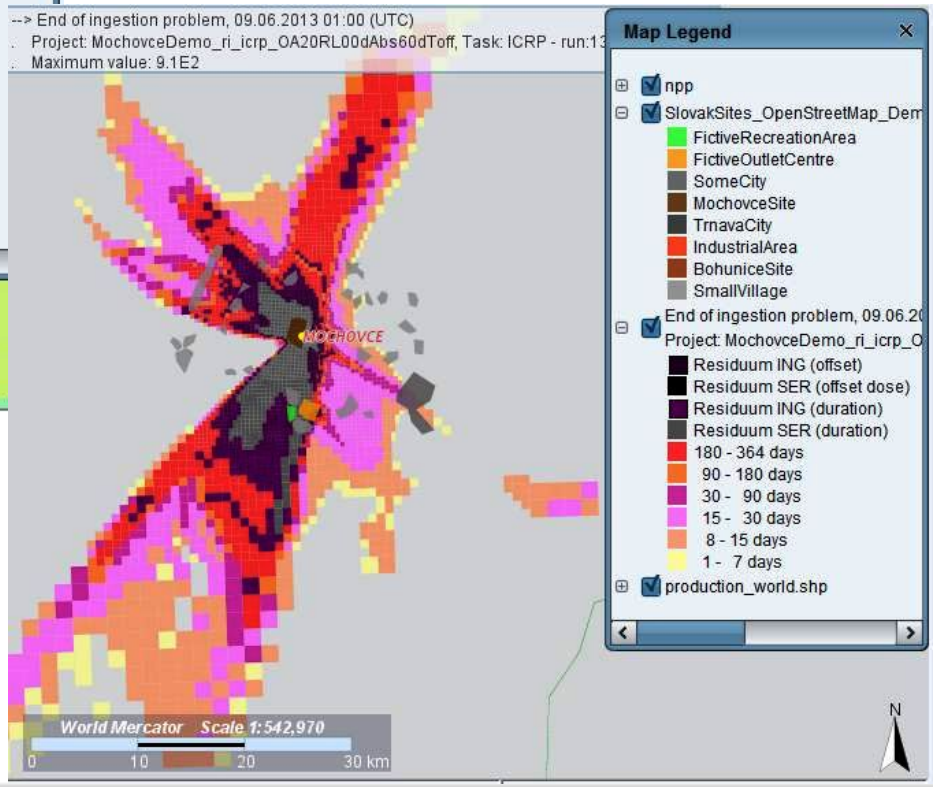
- CD(grid cell, after S-E-R+I actions)

- **=> Additional model step 4,** carried out after S-E-R+I screening in each grid cell of the JRodos grid (not only in the AoI as the S-E-R+I analysis); with quantity CDR setting the location-dependent limit for all ingestion doses other than covered by approach IG2
- Approach IG2 is suitable for locally produced foodstuffs consumed by critical local consumer groups who may or may not *(user selectable)* care about CFILs

Main results of ingestion screening analysis



Left: Ingestion dose, food basket, case CFILs = no, to be compared with CDR (CD remainder) => "Ingestion Criterion Dose"



Right: Result of check if uncontaminated food replacement would bring the ingestion dose below CDR. If yes, day is recorded when there is no longer an ingestion problem for the grid cell under consideration until the end of the first year.

Summary

- The JRodos ICRP-103 model SCREEN identifies a set of actions by analysing sheltering, evacuation/relocation, food restrictions, and thyroid blocking with respect to the potential for reducing the criterion dose in the first year below a given reference level
- The approach is consistent in the sense that the effect of all actions is considered under the common constraint of the Criterion Dose
- The current SCREEN does not take into account sheltering and evacuation based on national intervention levels => Potential for further development

Publication: Landman C., Päsler-Sauer J., Raskob W. Trybushnyi D. (2013) A Proposed countermeasure simulation model for the new ICRP recommendations, in: Duranova D, Raskob W, Mustonen R, Schneider T (editors), First NERIS Platform Workshop, Radioprotection, Volume 48, No. 5, S49-S56 (model description)

Thank you
for your attention

Questions?