The impact of different ADMs in the results of the European Model for Inhabited Areas after a Radiological Scenario

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Goals of this study

- Test the outcomes of the ERMIN model when using distinct deposition conditions created by different Atmospheric Dispersion Models (ADMs);
  - Are the results for different recovery strategies (tested using ERMIN) affected by using different ADM's?
- Assess the data needs for running ERMIN and coordinate these requirements with national databases.

Methodology

Where and When?

Weather conditions

Radiological details of accident

JRODOS:

Real-time **O**n-line **D**ecisi**O**n **S**upport system

ADM1

ADM2

ADM3

Deposition Map 1

Deposition Map 2

Deposition Map 3

ERMIN run 1

ERMIN run 2

ERMIN run 3

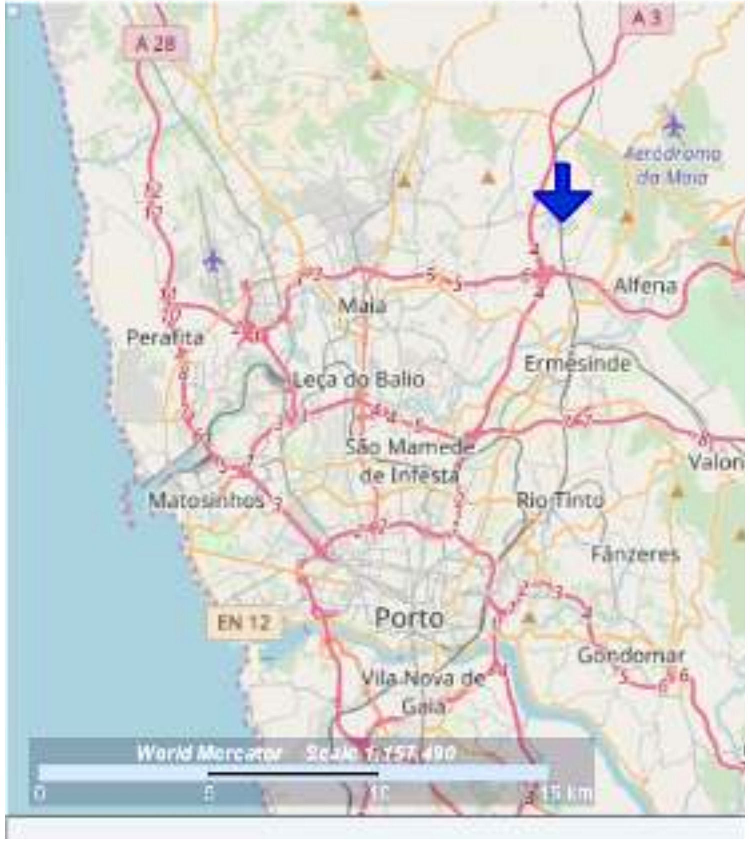
Definition of the Emergency Scenario

- The impact of a radiological accident such as a source meltdown in a steel mill was the chosen scenario.

- Its impact on a densely populated inhabited area was assessed:
  - ➢ Atmospheric Dispersion Models;
  - ➢ European Model for Inhabited Areas (ERMIN).

- The current work is focused in the downtown area of Porto.

Definition of the Emergency Scenario – Where and when?



Accident Site:

Lat: +41.257°

Long: -8.557°

Steel mill in the vicinity of Porto, 2nd Largest city in Portugal.

Date of Accident:

February 2nd, 2018, 12:00 UTC

Radioactive Source:

Radionuclide: Am-241

Activity: 740 TBq

Definition of the Emergency Scenario – Radiological details

Initial Radioactive Source:

Radionuclide: Am-241

Activity: 740 TBq

Used in well logging equipment

Partitioning

Distribution ratios expected upon inadverted meltdown *

- ✓ **Melt**: 0%
- ✓ **Slag:** 99 %
- ✓ **Dust:** 1%

*ISIJ International, 45 (2005), 2, 288-295

Calculation Source-Term:

Radionuclide: Am-241

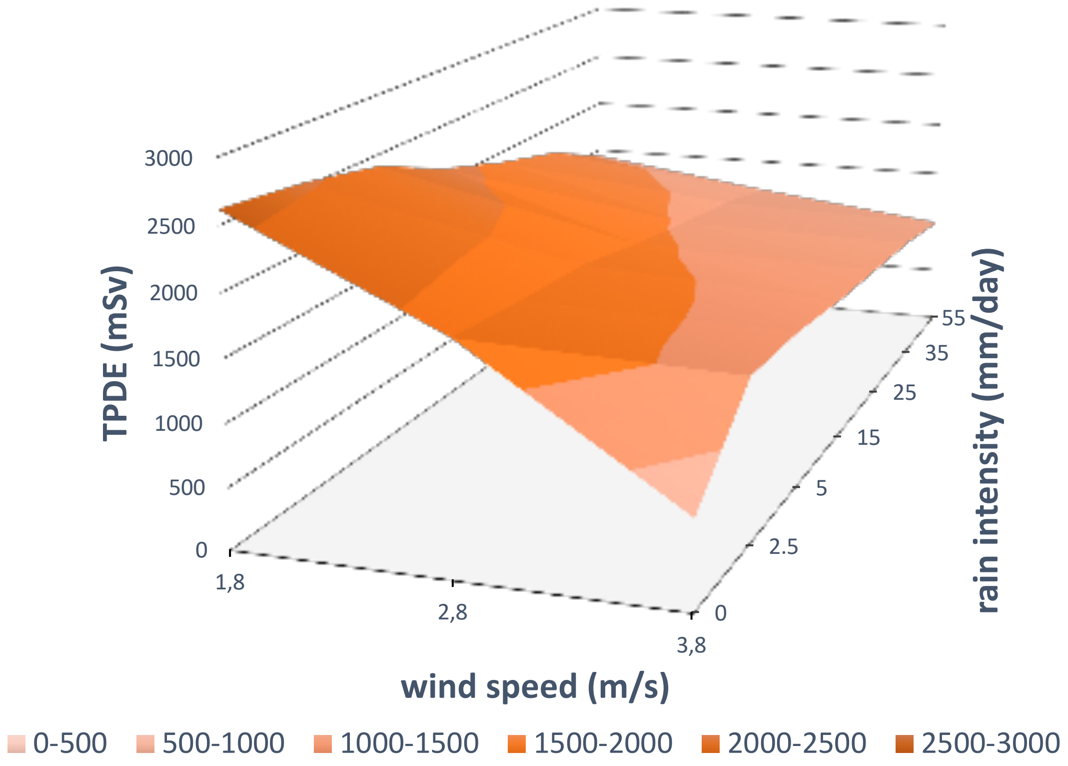
Activity: 7.40 TBq

Definition of the Emergency Scenarios – Weather conditions

- Several weather condition sets (wind vector and rain intensity) were tested to obtain a high impact deposition scenario in the area of interest (Porto downtown area).

- The value for the Total Potential Dose Effective (TPDE) in mSv was used to evaluate the impact of a set of weather conditions.

- All runs were carried out using a single ADM (RIMPUFF) and a single Source Term.



Emergency Scenarios: Deposition maps

The deposition maps were obtained by running **JRODOS-2017** update

- RAC-with-Fire module
- Weather by user input
- Model Chain: LSMC+EMERSIM+DEPOM+FDMT

ADM= LASAT

ADM= RIMPUFF

ADM= DIPCOT

The European Model for Inhabited Areas (ERMIN)

- The European Model for Inhabited Areas (ERMIN) allows the evaluation and comparison of different recovery strategies.

- ERMIN allows flexibility to describe the urban environment and the contamination extent.

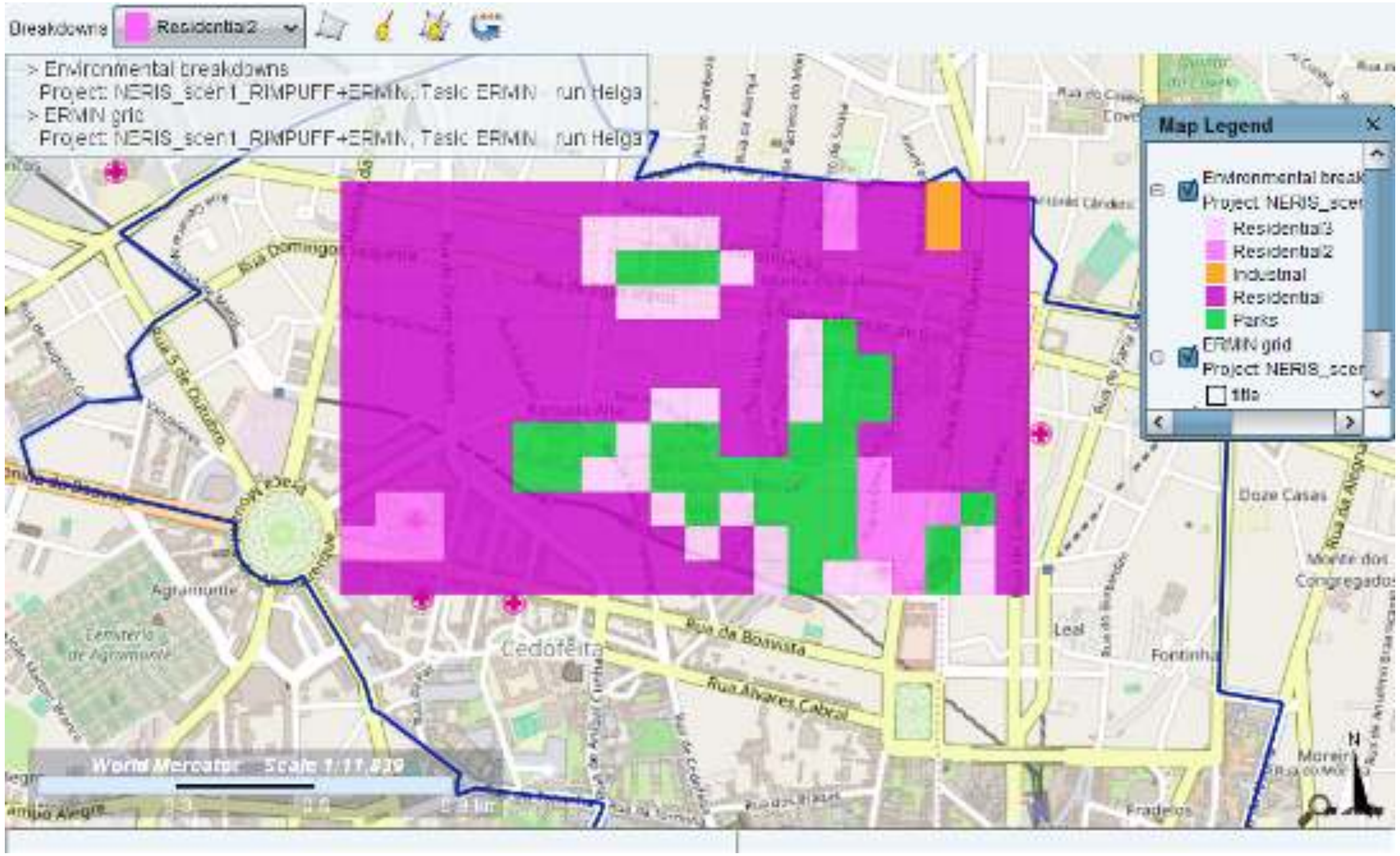
- The chosen Area of Interest has a high variability of predicted deposition.

- Due to the nature of the accident, no early counter-measures were taken into account since it was considered that the release was detected after the deposition has occurred.

ERMIN INPUTS: Environmental Breakdown

- The National Land Cover database (DGT-COS2010) was used to create the Porto Downtown Environmental Breakdown in the Area of Interest.

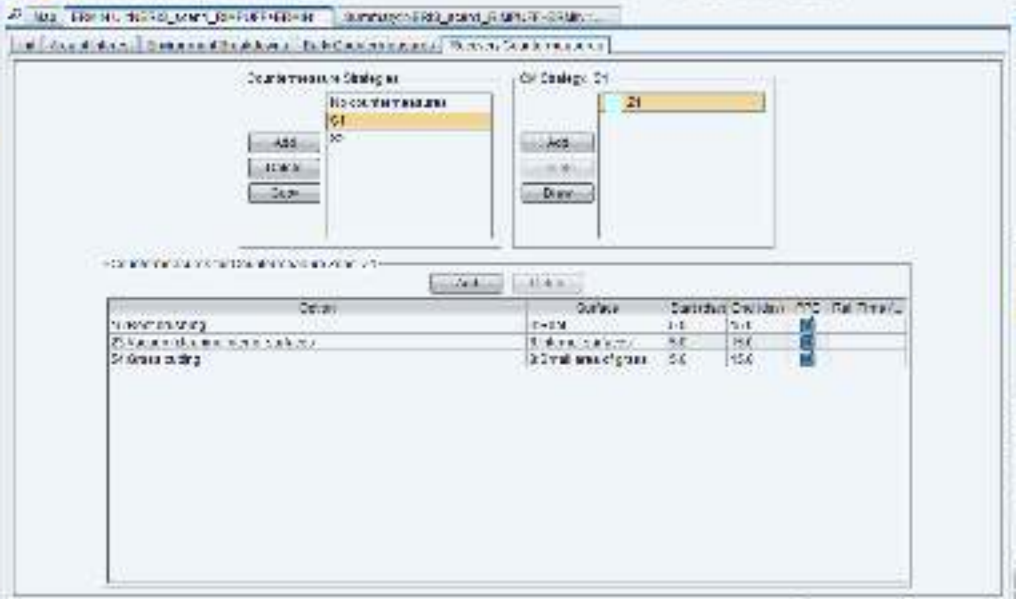
- 5 Urban Environments were identified:
  - **Parks**
  - **Industrial Areas**
  - **Residential**: Multi-storey block of flats amongst other house blocks
  - **Residential2**: Multi-storey block of flats opposite parkland
  - **Residential3**: Street of semi-detached houses without basement

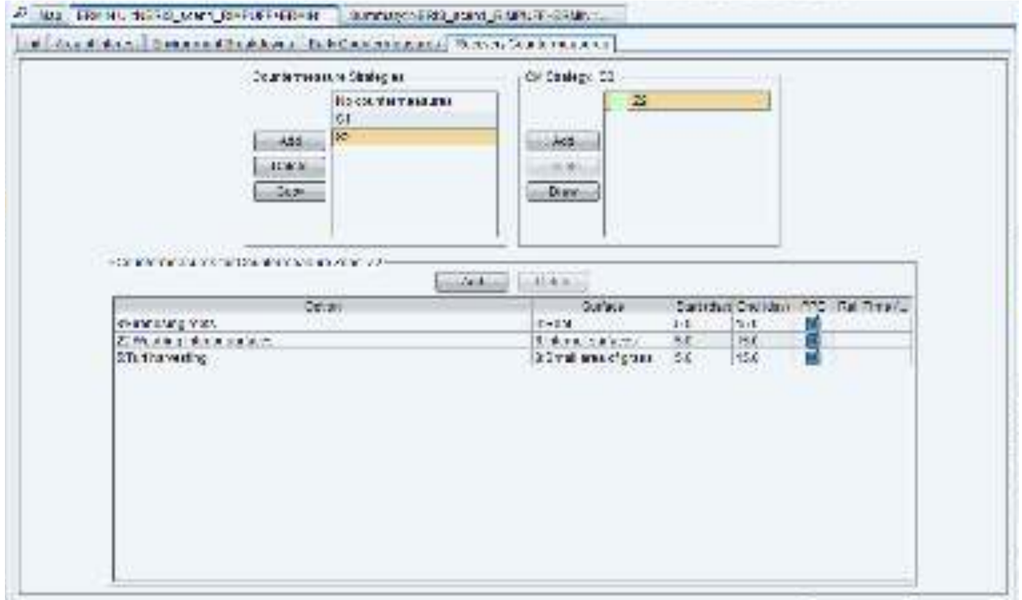


ERMIN INPUTS: Outlined Strategies

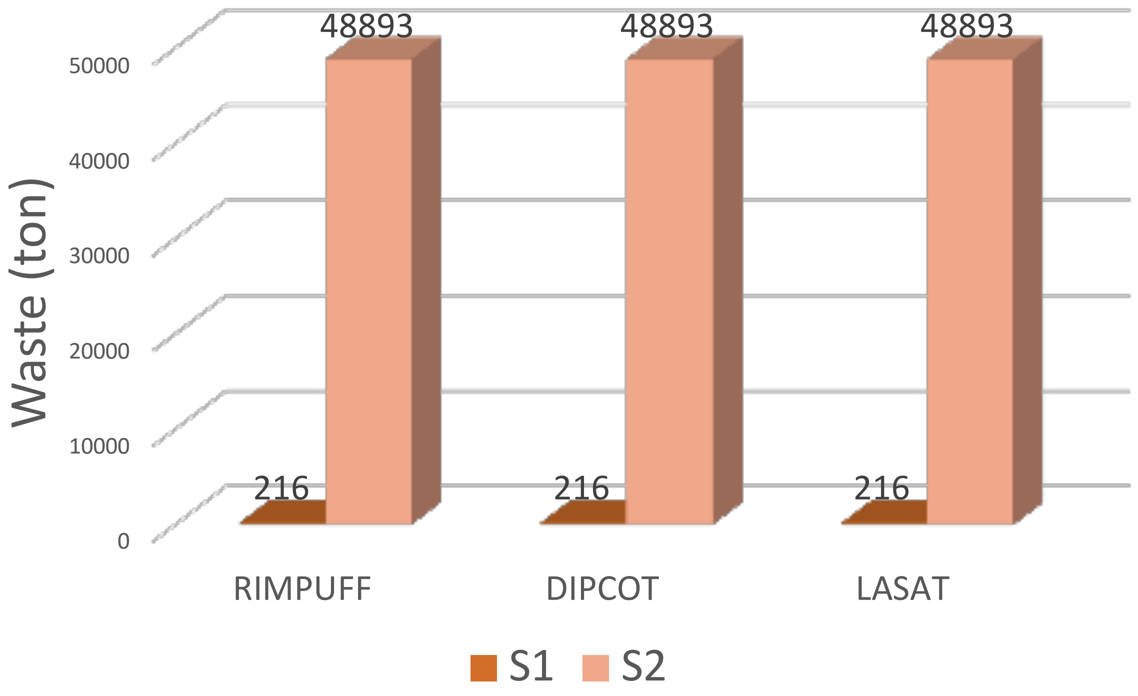
Proposed strategies combine 3 counter-measures and are applied to all Area of Interest:

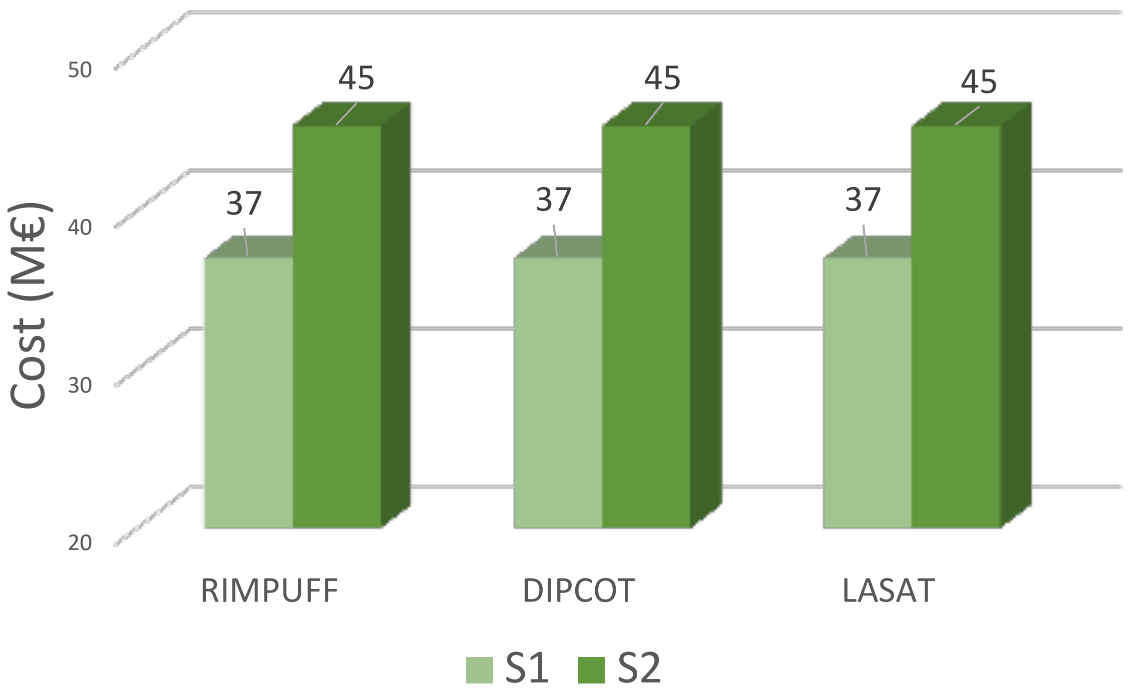
- S0: No counter Measures;
- S1: Lower cost / lower waste production
  - Roof Brushing
  - Vacuum Cleaning Interior Surfaces
  - Grass cutting
- S2: Higher cost / higher waste production
  - Fire hosing Roofs
  - Washing Interior Surfaces
  - Turf Harvesting





Results

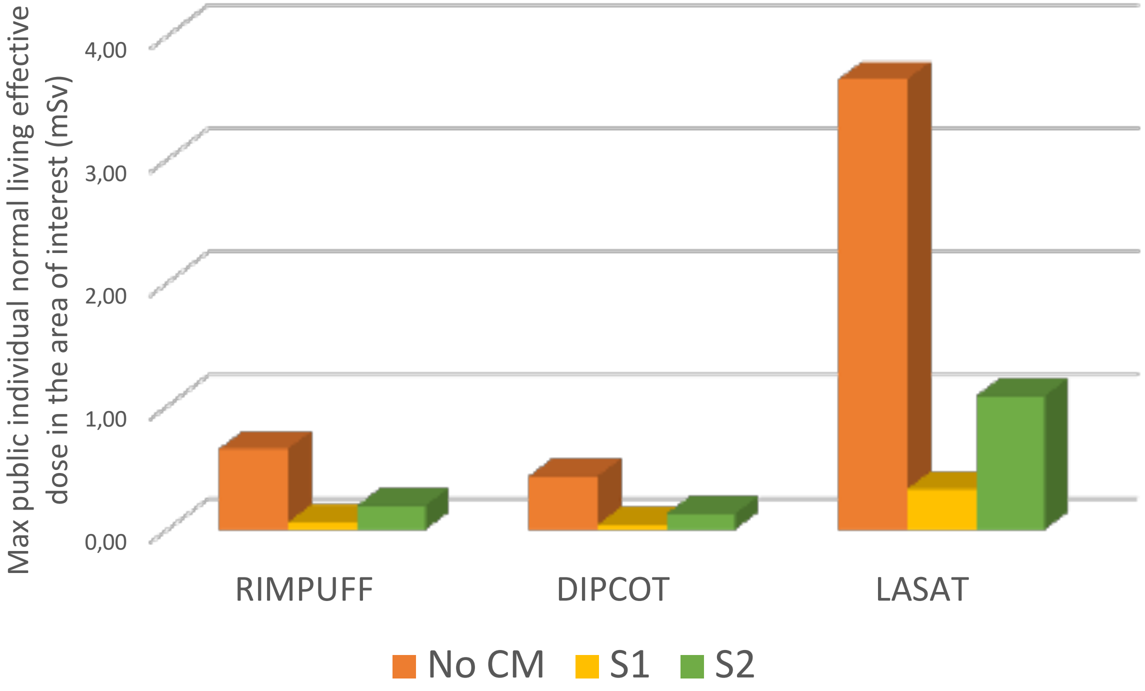




Total waste produced (ton) and **the total cost** of each strategy are independent of the ADM used

Results

As a measure of effectiveness of each strategy, the values of **maximum public individual normal living effective dose** in the area of interest over a 10 year integration period (= the sum of the dose from exposure to external irradiation over the period and committed effective dose from inhalation of radioactivity over the same period) were used.

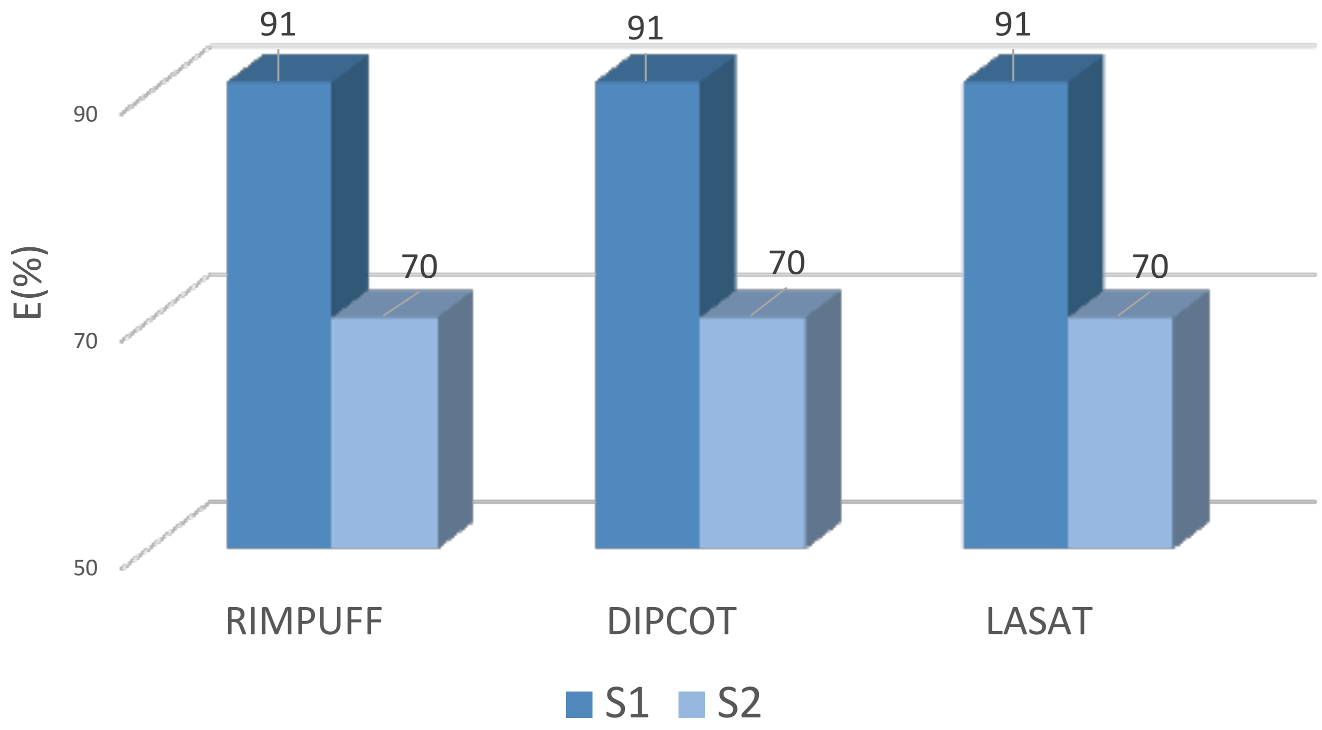


Highly dependent of ADM used

Results

If these values of the **maximum public individual normal living effective dose** (mSv) are converted to the **effectiveness** (E) of each strategy

$$E_{S_i}\,(\%) = \frac{D(S_0) - D(S_i)}{D(S_0)} \times 100$$



Independent of ADM used

Conclusions

- For this scenario and these proposed strategies, S1 combines a better effectiveness with lower costs, independently of the obtained dispersion map.

- The values for maximum public individual normal living effective dose are highly dependent on the type of model used
  - ADM should be carefully adequate to the type of accident area;
  - Creates uncertainties when results are presented to decision makers.

- ERMIN model is robust and the analysis of costs and efficiency of the proposed recovery strategies are independent of ADM
  - Reduces uncertainties when analyzing different types of recovery strategies with the decision makers.

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Thank you for your attention

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