

# European Model for Inhabited Areas (ERMIN)



Tom Charnock

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# Introduction



The ERMIN work-package

The Model

The Database

Implementation as an operational tool

# ERMIN work package of the EURANOS project



## Work package partners:

Health Protection Agency, Centre for Radiation, Chemical and Environmental Hazards, U K

Risø National Laboratory for Sustainable Energy, Technical University of Denmark, Denmark

Helmholtz-Zentrum Muenchen, Germany

Forschungszentrum Karlsruhe, IKET, Germany

Danish Emergency Management Agency, Denmark

Prolog Development Center, Denmark

Bundesamt für Strahlenschutz, Germany

Development of ERMIN model

Development of Inhabited Area Monitoring Module (IAMM)

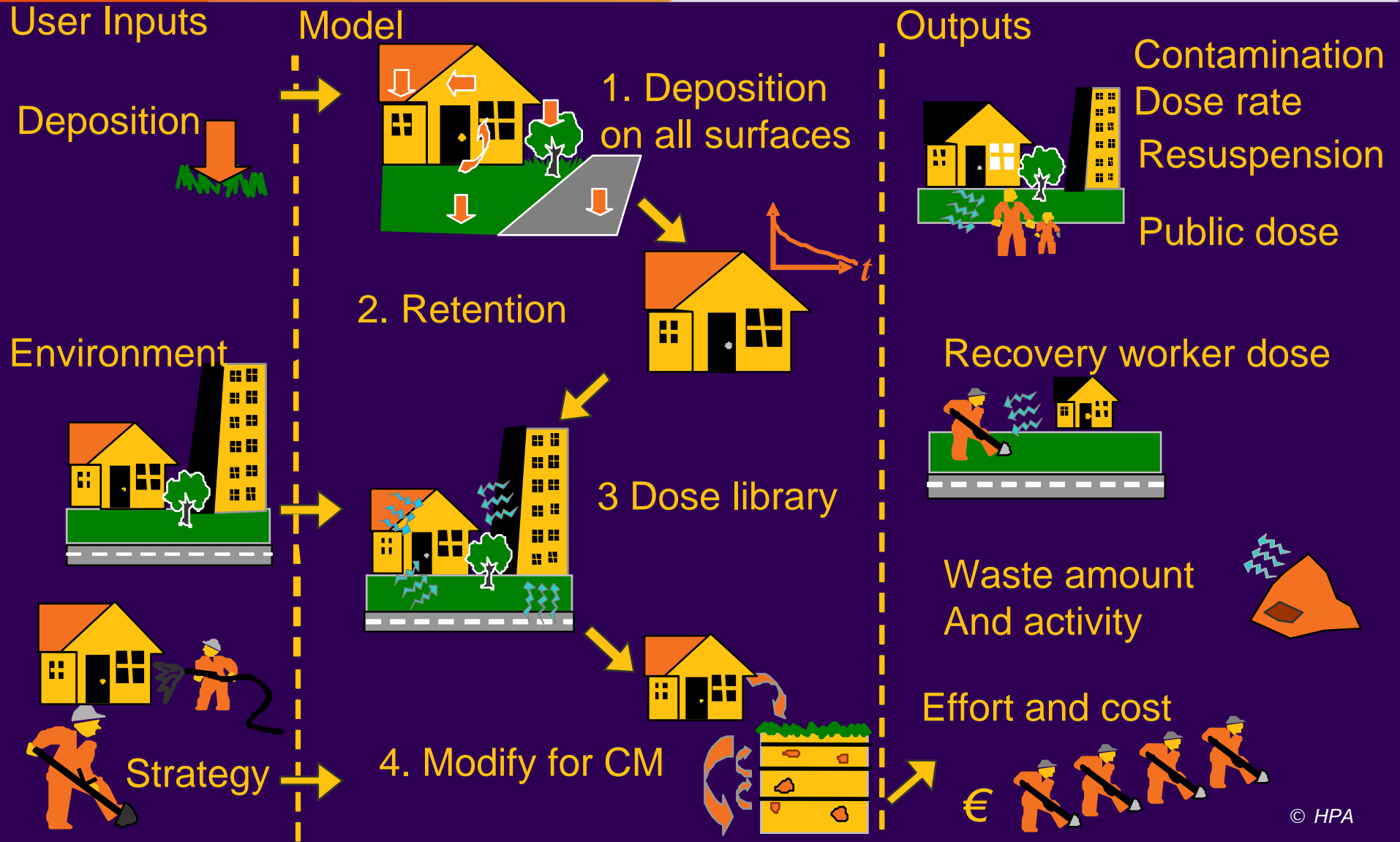
Integration of both within ARGOS and RODOS – Operational!

***EURANOS***



© HPA

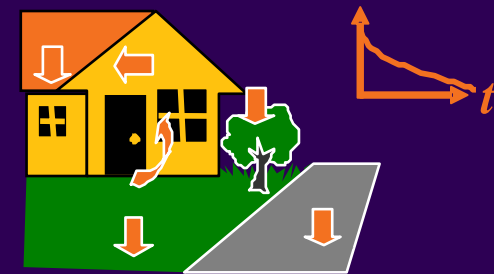
# The ERMIN model



# Data: Initial Deposition and Retention



Initial deposition and retention:  
Extensive review of the literature  
Most suitable for a reactor accident  
Dry, wet and wet/dry



# Data: Idealised environments



**Based on existing studies; Monte Carlo modelling**

**Unit dose rates; modification and completion required**

**Beta dose; simple assumptions**

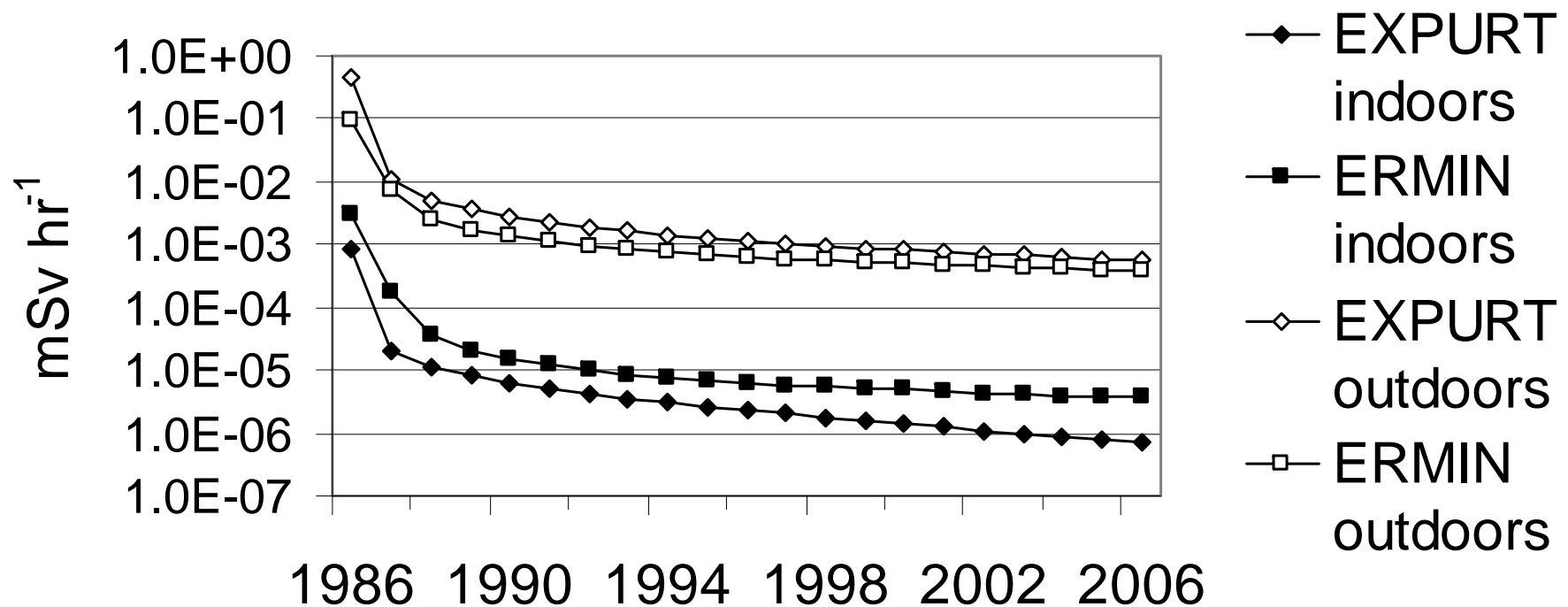


<b>Street of detached prefabricated houses</b>	<b>Meckbach et al, 1988</b>
<b>Street of semi-detached houses with basement</b>	<b>Meckbach et al, 1988</b>
<b>Street of semi-detached houses without basement</b>	<b>Jones et al, 2006</b>
<b>Street of terraced houses</b>	<b>Meckbach, 1988</b>
<b>Multi-storey block of flats amongst other house blocks</b>	<b>Meckbach, 1988</b>
<b>Multi-storey block of flats opposite parkland</b>	<b>Meckbach, 1988</b>
<b>Industrial site (Incomplete dose library)</b>	<b>Kis et al, 2003</b>
<b>Large open area</b>	<b>Jones et al, 2006</b>

# Comparison with EXPURT - total dose rate



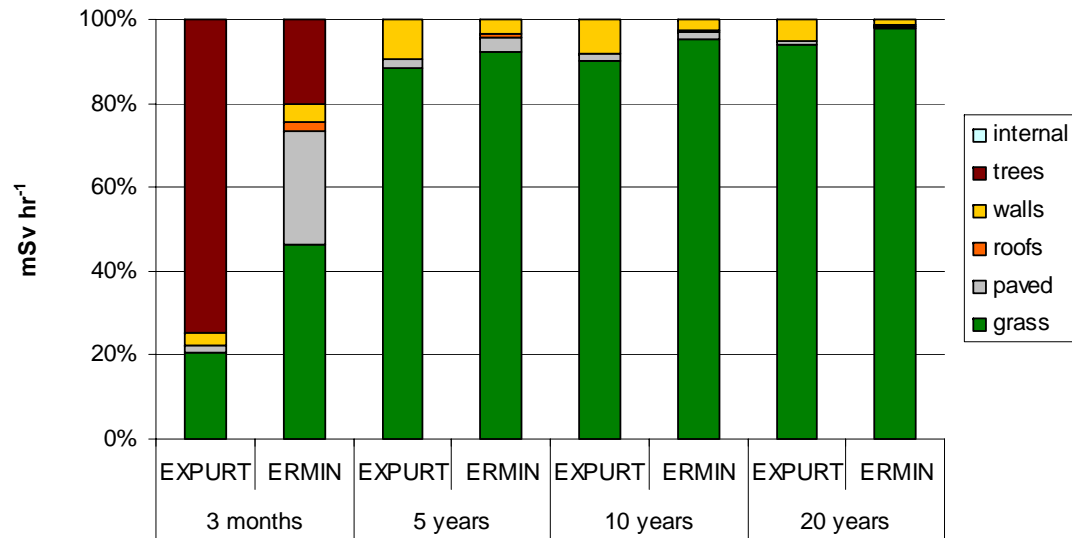
Predicted external gamma dose rate indoors and outdoors in a multi-storey building environment



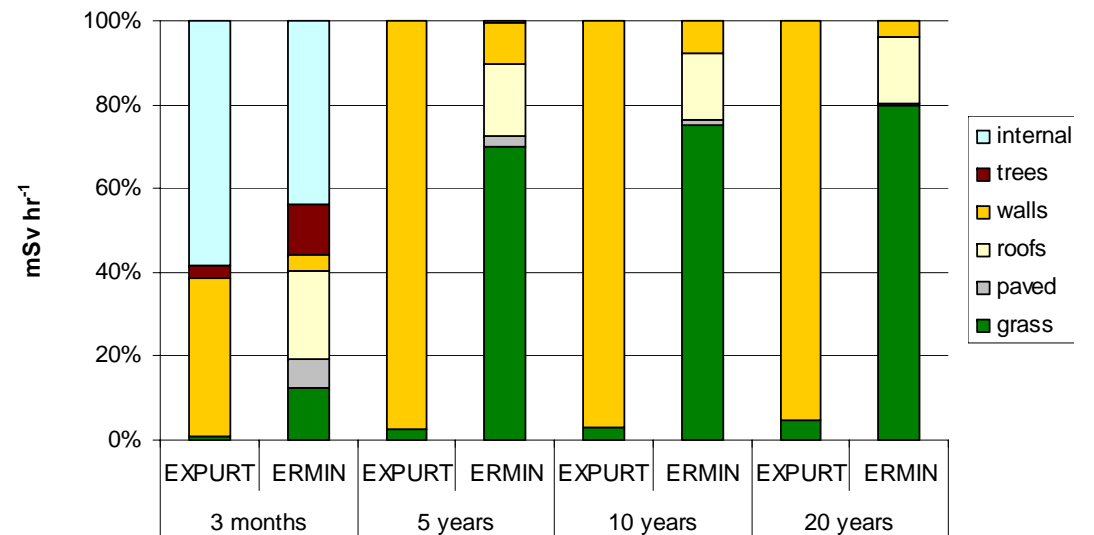
# Comparison with EXPURT – dose rate by surface



Fraction of outdoor dose rate



Fraction of indoor dose rate





- Recovery strategy
  - Radiological: dose
  - Logistical: equipment, manpower, time
  - Acceptability to stakeholders: perception, legality
- Health professionals, government, residents, other users of the area, workers implementing strategy etc
- EVATECH project: how decision makers work

Implemented as modules in RODOS and ARGOS

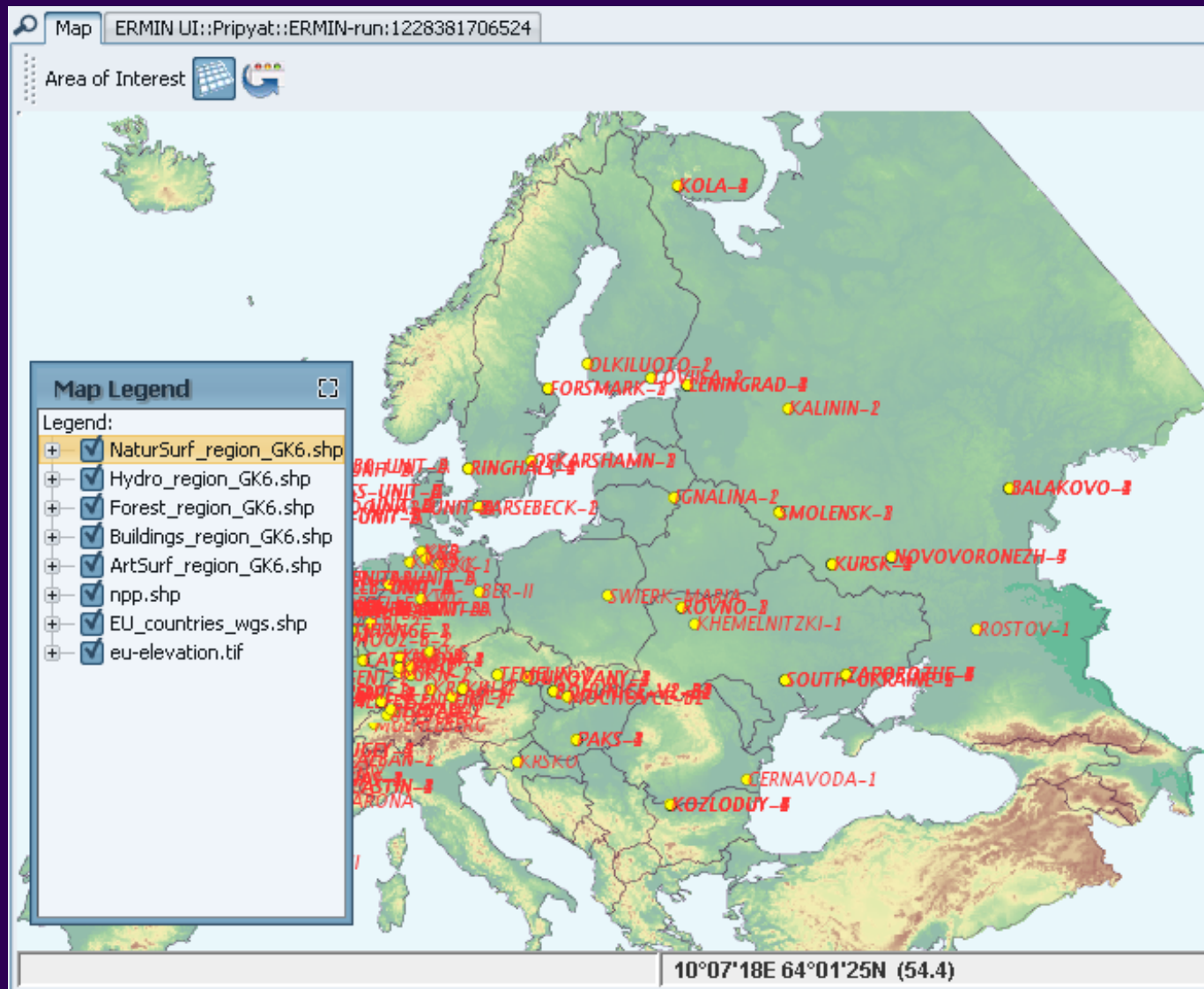
User interaction by defining regions

environment description, deposition, emergency countermeasures, recovery countermeasures

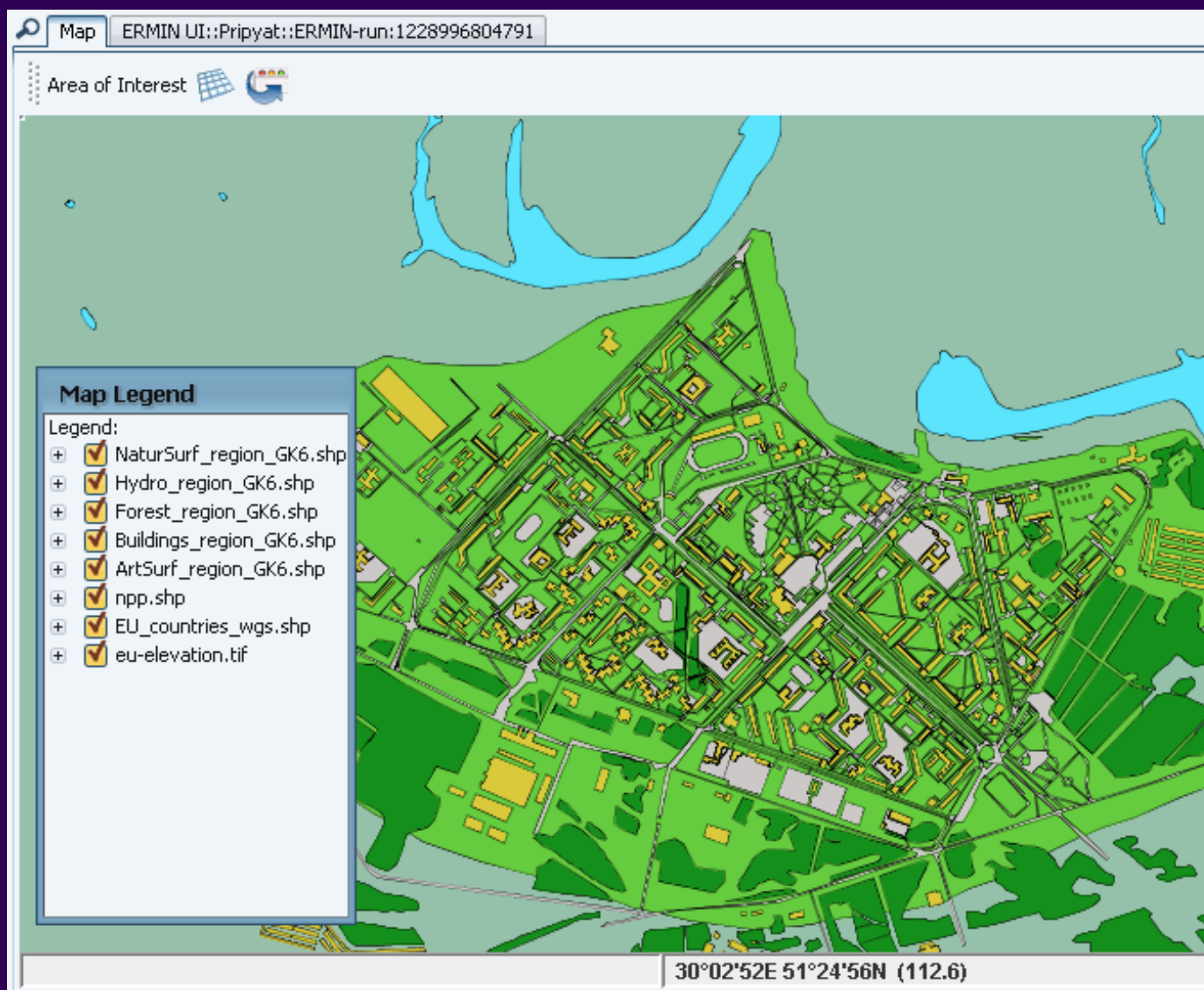
RODOS and ARGOS can also take deposition from ADM or IAMM

RODOS and ARGOS; map based interface

# Example scenario - JRODOS



# Example scenario - JRODOS





# Example scenario – area of interest



Map ERMIN UI::Pripyat::ERMIN-run:1228996804791

Area of Interest

## Map Legend

Legend:

- NaturSurf\_region\_GK6.shp
- Hydro\_region\_GK6.shp
- Forest\_region\_GK6.shp
- Buildings\_region\_GK6.shp
- ArtSurf\_region\_GK6.shp
- npp.shp
- EU\_countries\_wgs.shp
- eu-elevation.tif

30°04'03E 51°24'00N (112.6)

# Example scenario – initial deposition



## Atmospheric model, direct input and IAMM

Map ERMIN UI::Pripyat::ERMIN-run:1229676191745

Deposition zones: District 1

--> Deposition zones  
--> ERMIN grid

**Map Legend**

Legend:

- Deposition zones
  - District 4
  - District 1
- ERMIN grid
  - title
- NaturSurf\_region\_GK6.shp
- Hydro\_region\_GK6.shp
- Forest\_region\_GK6.shp
- Buildings\_region\_GK6.shp
- ArtSurf\_region\_GK6.shp
- npp.shp
- EU\_countries\_wgs.shp
- eu-elevation.tif

30°02'58E 51°24'52N (112.6)

Deposition data

Deposition zones

- District 1
- District 4

Add

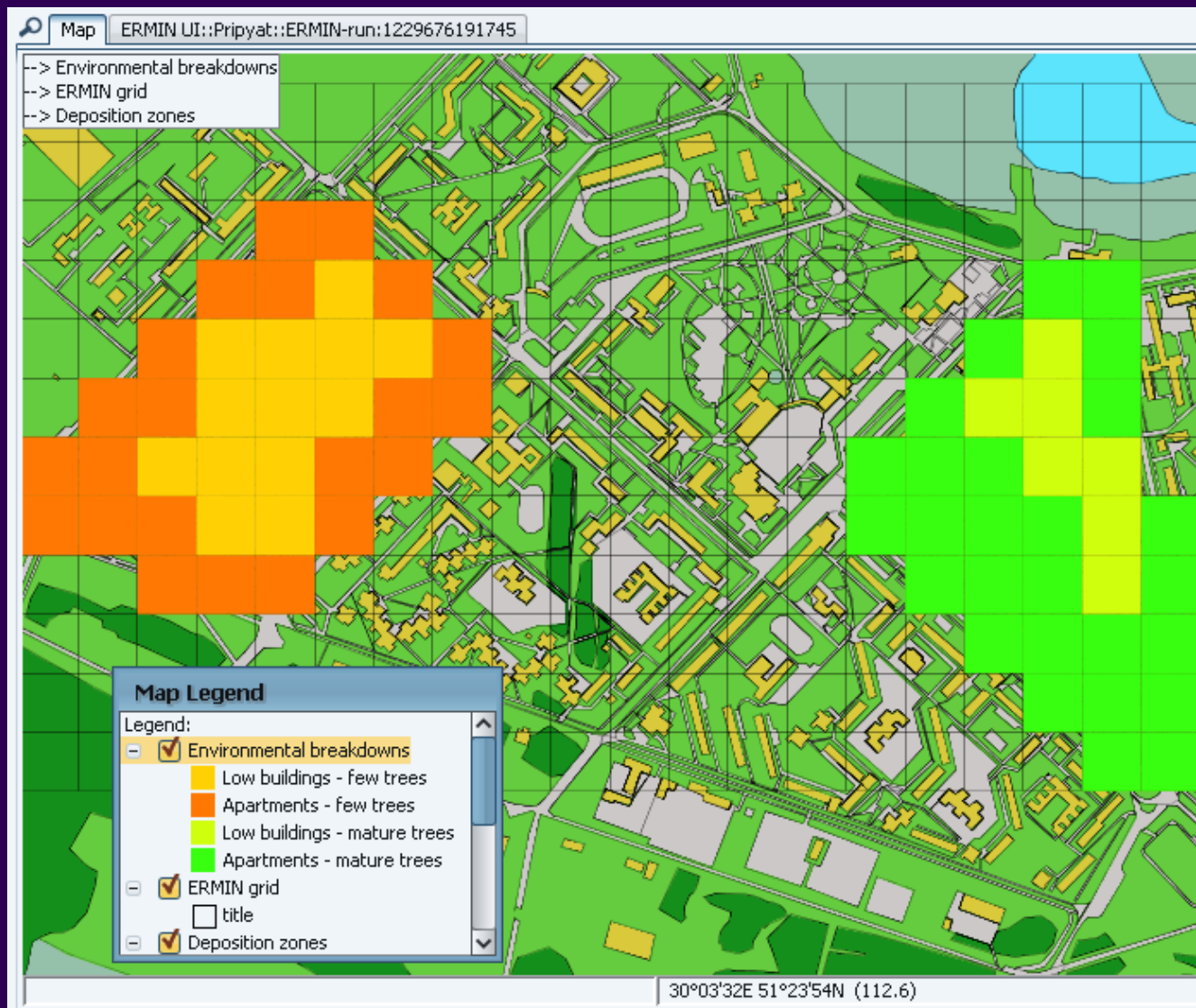
Delete

Draw

Deposition for zone: District 1

Ce-141	33,300,000	Dry conditions
Ce-144	25,300,000	Wet conditions
Cs-134	1,100,000	Roughly equal dry/wet conditions
Cs-137	2,040,000	
Nb-95	49,400,000	
Ru-103	29,300,000	
Ru-106	6,600,000	
Zr-95	49,400,000	
Pr-144	0	
Ba-137m	0	
Rh-103m	0	
Rh-106	0	

# Example scenario – environment description





# Example scenario – countermeasure strategy





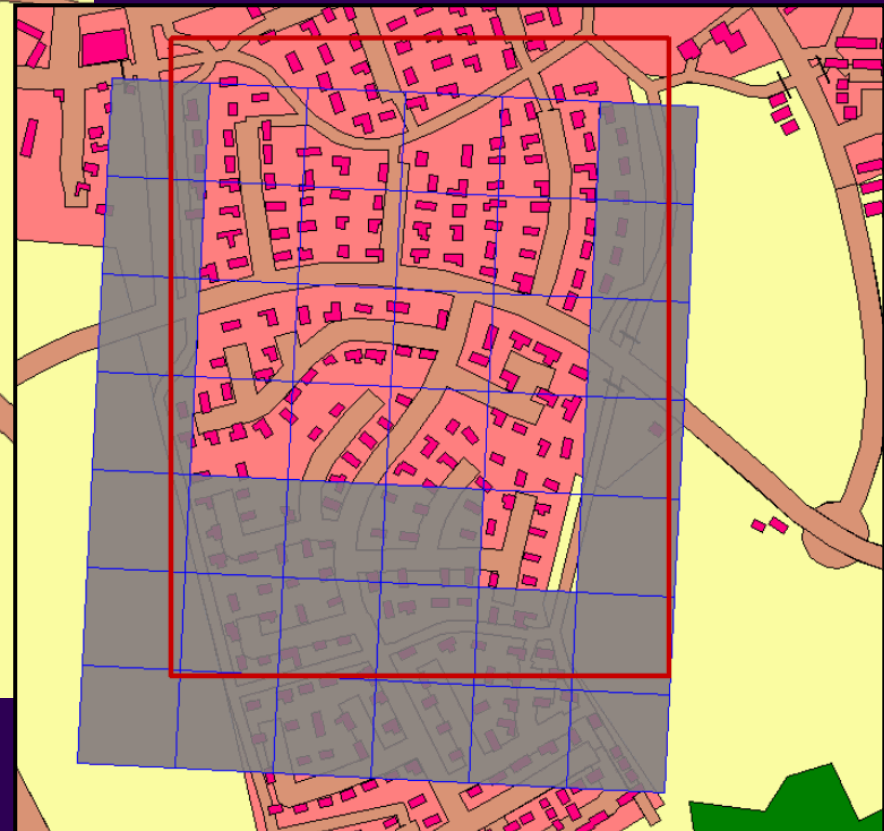
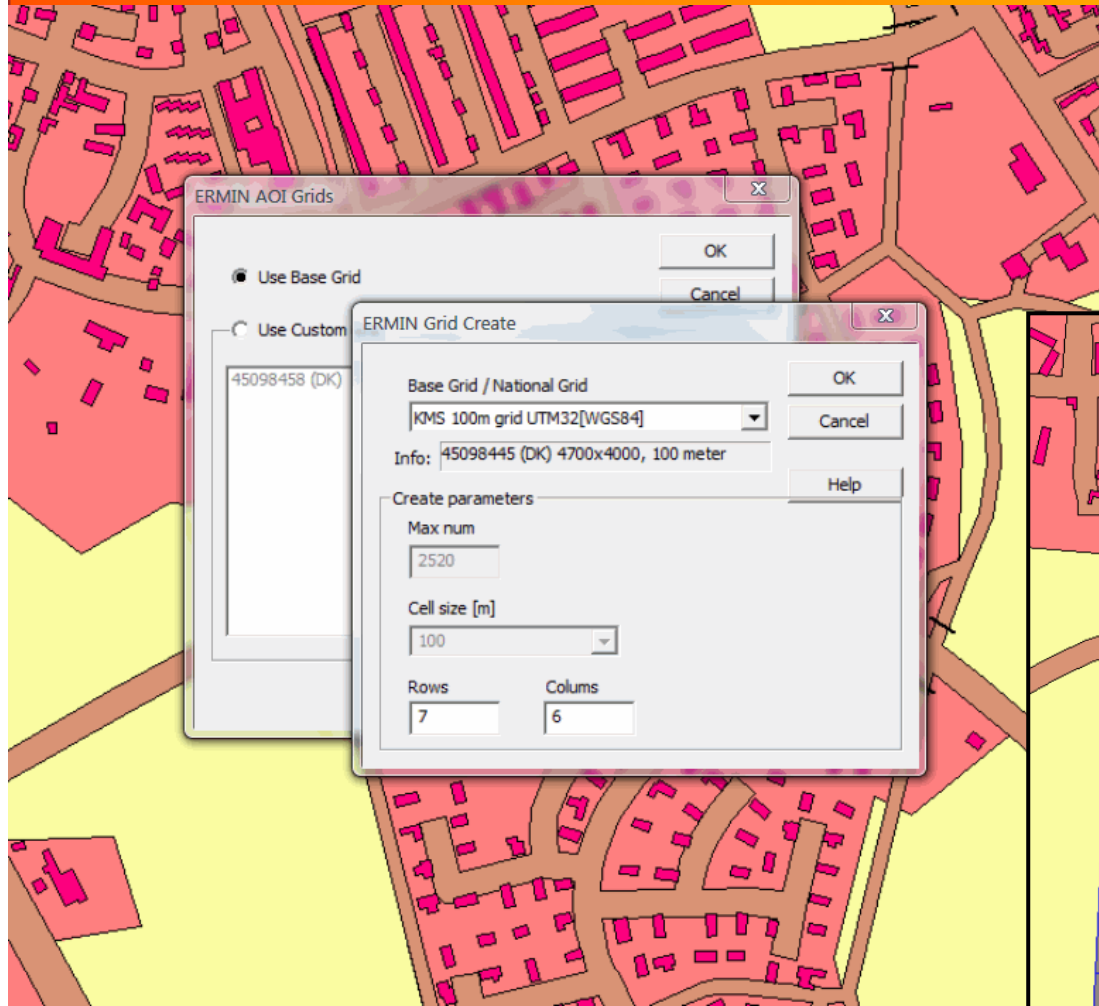
# Example scenario – comparing strategies



Position	No countermeasures (365.0 days)	Relocation district 1	Grass cutting only
Total waste produced (kg)	0.0	0.0	23876.0
Maximum beta/gamma emitting radionuclide concentration produced (Bq kg-1)	0.0	0.0	1.61304346E9
Maximum alpha emitting radionuclide concentration produced (Bq kg-1)	0.0	0.0	0.0
Average beta/gamma emitting radionuclide concentration produced (Bq kg-1) calculated from the total beta/gamma emitting radionuclide removed (Bq) divided by the total material removed (kg)	0.0	0.0	1.0352887E9
Average alpha emitting radionuclide concentration produced (Bq kg-1) calculated from the total beta/gamma emitting radionuclide removed (Bq) divided by the total material removed (kg)	0.0	0.0	0.0
The total man days that the population of the area of interest is outside the area of interest because of evacuation or relocation (man days)	0.0	0.0	0.0
The maximum total area affected by evacuation and relocation (m2)	0.0	340000.0	0.0
The total m2 days that are lost to evacuation and relocation (m2 days)	0.0	2040000.0	0.0
The maximum individual worker dose from any single countermeasure applied anywhere in the area of interest (Sv)	0.0	0.0	3.672179E-4
The total collective workdose from all countermeasures applied in the area of interest (man Sv)	0.0	0.0	0.009862037
The total public collective normal living effective dose (man Sv) in the area of interest over a defined integration period	0.0	0.0	0.0
The saved total public collective normal living effective dose (man Sv) in the area of interest over a defined integration period	0.0	0.0	0.0
The total collective public normal living skin dose in the area of interest over a defined integration period from external exposure to beta radiation (man Sv)	0.0	0.0	0.0
The saved collective public normal living skin dose in the area of interest over a defined integration period from external exposure to beta radiation (man Sv)	0.0	0.0	0.0
The maximum public individual normal living effective dose in the area of interest over a defined integration period (Sv). 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	0.28369495	0.2679136	0.2709546
The maximum saved public individual normal living effective dose in the area of interest over a defined integration period (Sv). 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	0.0	0.015781343	0.012905464
The maximum public individual normal living skin dose from exposure to external beta radiation in the area of interest over a defined integration period (Sv)	1.3531139	1.2949849	1.1657126
The maximum saved public individual normal living skin dose from exposure to external beta radiation in the area of interest over a defined integration period (Sv)	0.0	0.058128953	0.21403831
The amount work required for implementing the countermeasure strategy in the area of interest (man days)	0.0	0.0	0.99483335
The amount of personnel required for implementing the countermeasure strategy in the area of interest (man)	0.0	0.0	69.0

Exported to Web-HIPRE decision analysis tool © HPA

# Implementation in ARGOS



# Implementation in ARGOS



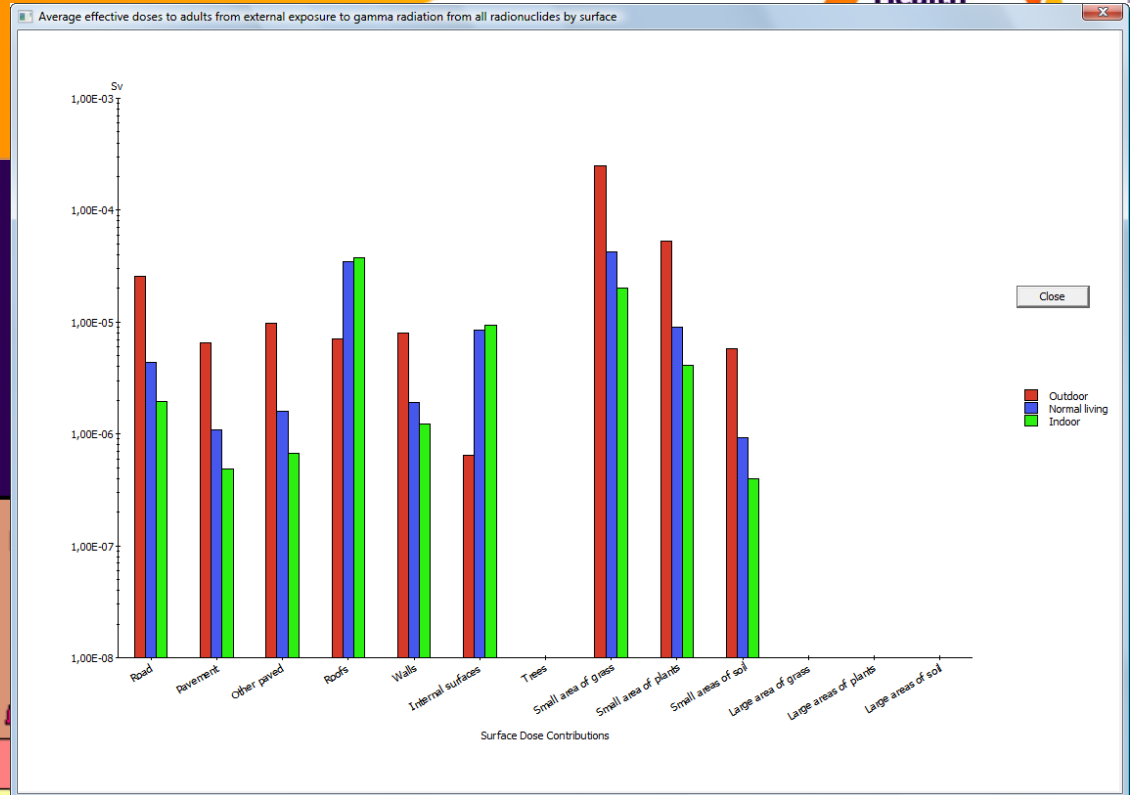
The screenshot shows the "Environment Breakdown" dialog box in the ARGOS software. The dialog box is overlaid on a map showing a residential area with buildings and streets. The dialog box contains the following fields and options:

- Grid Cell ID:** 45098445\_8350031
- Environment Regions:** residential (dropdown menu)
- Enter name for new region or choose from list**
- Buildings (Environments):** 1 (dropdown), 4 (dropdown), [empty] (dropdown), [empty] (dropdown), [empty] (dropdown), Same as last (button)
- Green areas and pavement (Sets):** 4 (dropdown), 4 (dropdown), [empty] (dropdown), [empty] (dropdown), [empty] (dropdown)
- Fractions (r):** 0.25 (input field)
- Info** (button)
- Help** (button)
- OK** (button)
- Cancel** (button)

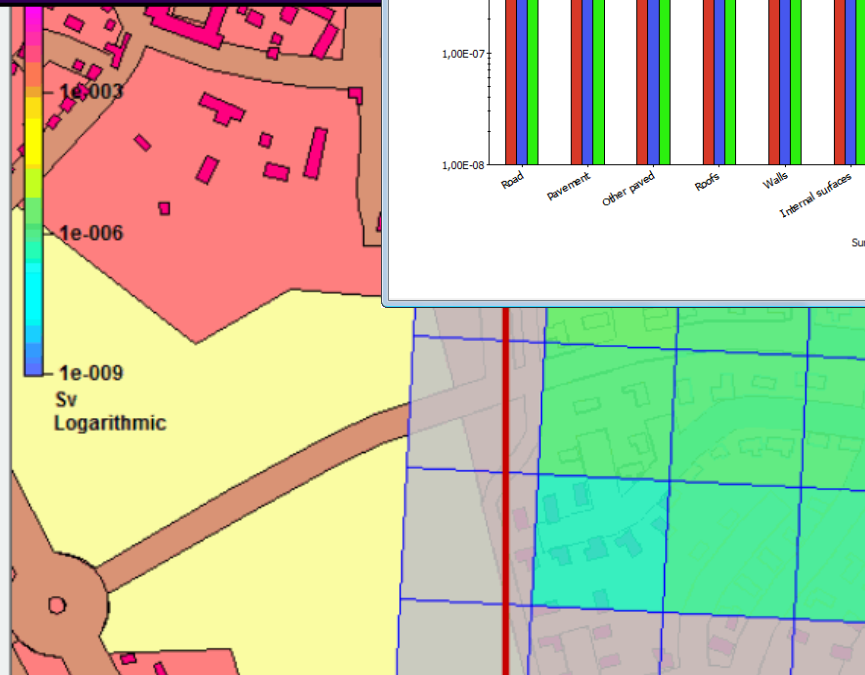
The "Green areas and pavement (Sets)" dropdown menu is open, showing a list of options:

4	No trees default paved
5	Default trees high paved
6	High trees high paved
7	Low trees high paved
8	No trees high paved
9	Default trees low paved
10	High trees low paved
11	Low trees low paved
12	No trees low paved

# Implementation in ARGOS



- Ermin
  - Screening
    - Normal Living (sum)
  - Dose
    - Total
      - Normal Living
        - Indoor
        - Outdoor
      - Gamma
        - Normal Living
          - Indoor
          - Outdoor
        - Beta
          - Normal Living
            - Indoor
            - Outdoor
          - Resuspension
            - Normal Living
              - Indoor
              - Outdoor



# Future work



Project proposal to expand database for explosion scenarios:  
initial deposition, long term retention, decontamination  
Additional environments?