



Public Health
England

Protecting and improving the nation's health

ERMIN, European Model for Inhabited Areas: use within a wider recovery decision making framework

Introduction

Introduction

ERMIN model and tool

- Development

- Model

- Implementation in jRODOS and ARGOS DSS

Using ERMIN within the recovery decision-making environment

- Challenges of recovery within inhabited areas

- Using ERMIN to support decision-making

- Examples

Summary/conclusions

ERMIN Development

EC Projects: EURANOS, NERIS-TP, PREPARE and HARMONE (OPERRA)

Partners: PHE, DTU, HMGU, KIT, DEMA, PDC, BfS, UCEWP

Implemented in jRODOS and ARGOS

Lessons learnt from development CONDO, LCMT(RODOS), and EXPURT

Currently looking at uncertainty in ERMIN in the EC project “Confidence” part of the CONCERT project

ERMIN model



Available Countermeasure Techniques Properties

Select	Option
<input type="checkbox"/>	1: Firehosing walls
<input type="checkbox"/>	17: Sandblasting walls
<input type="checkbox"/>	18: High pressure hosing walls
<input type="checkbox"/>	20: Treatment with ammonium nitrate
<input type="checkbox"/>	21: Mechanical abrasion of wooden walls
<input type="checkbox"/>	27: Peelable coatings
<input type="checkbox"/>	2: Turning paving slabs
<input type="checkbox"/>	4: Tie-down to paved with bitumen
<input type="checkbox"/>	12: Tie-down to paved with water
<input type="checkbox"/>	24: Firehosing paved

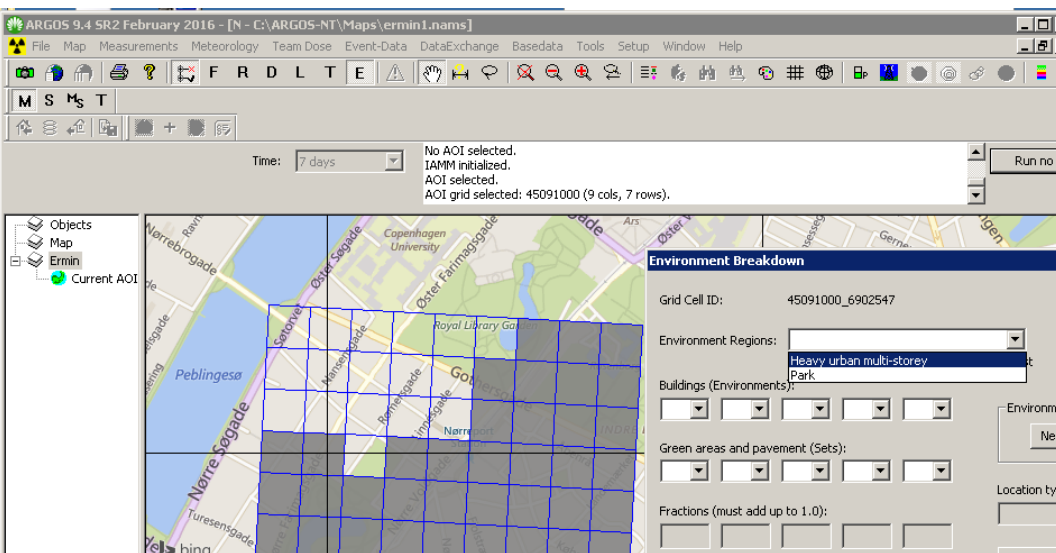
[jRODOS window for selecting options]

51 of the 59 Management options from European Recovery
[Handbook: <http://www.eu-neris.net/index.php/library/handbooks.html>]

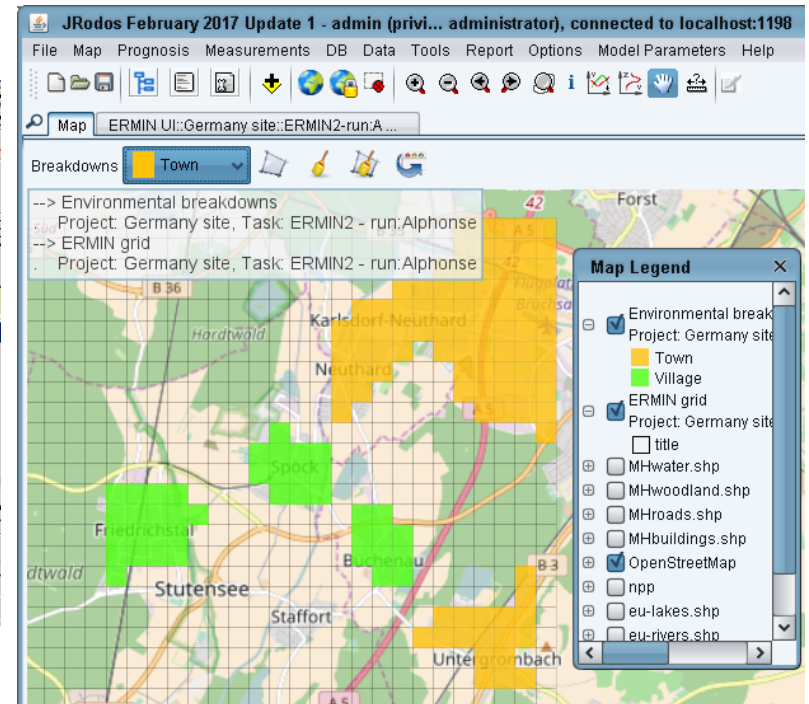
ERMIN - implementation

jRODOS and ARGOS: map based interface, user delineates zones of environments and management options

Initial contamination from Atmospheric Dispersion Model or user delineated deposition zones



ARGOS: assigning built-environment types to model grid squares



jRODOS: assigning built-environment types to model grid squares

Challenges of recovery in inhabited areas

A great many stakeholders, including the public

The accident and recovery options can profoundly impact peoples lives for many months or years

Decision-making is non-linear, it has feedbacks and iterations

Uncertainty on predictions of residual dose

A large number of management options; combinations, locations and implementation times

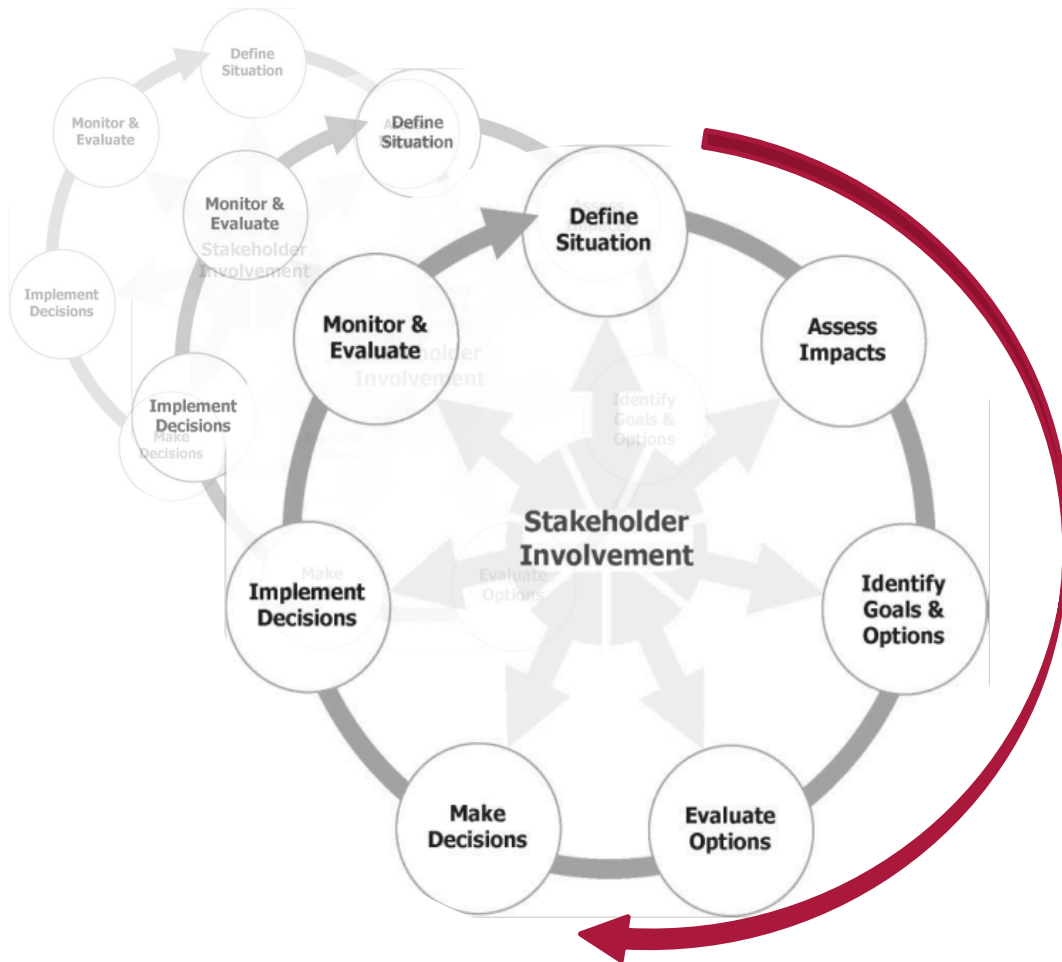
Different decision making processes/arrangements/structures possible

Rarely exercised

“... It is important that the public participate fully in establishing the goals for recovery, be they based on radiological, economic, environmental or other criteria.”

National Nuclear Emergency Planning and Response Guidance (NNEPRG 2015), <https://www.gov.uk/government/publications/national-nuclear-emergency-planning-and-response-guidance>

ERMIN in the decision making process



“Recovery is best achieved where the recovery process begins as early as possible during the response.”

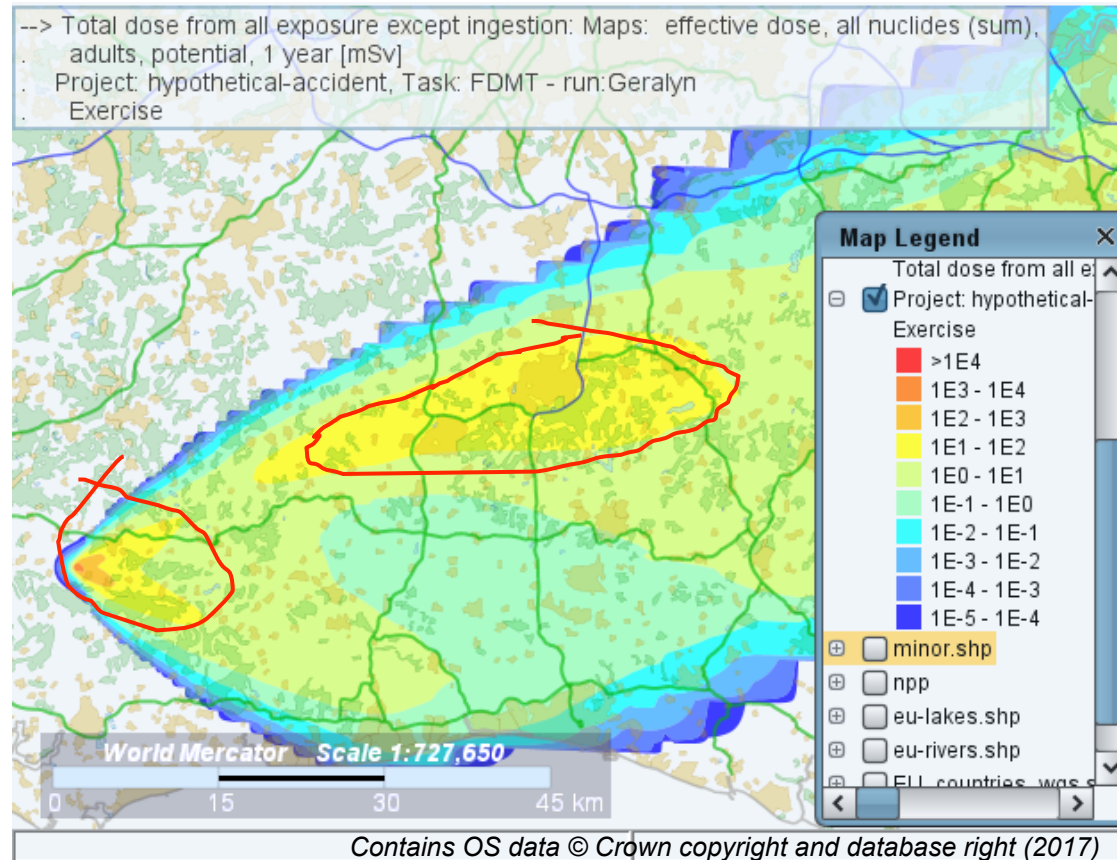
(NNEPRG 2015)

UK Recovery Handbooks for Radiation Incidents 2015
Inhabited Areas Handbook V4, PHE-CRCE-018: Part2

Define the situation

“Establish a picture of who or what has been affected, to what extent. Including levels of radioactive contamination, ... land use affected ... and impacts on people ...” (NNEPRG 2015)

In the early and transition phases little monitoring available: reliance on model output. Treat with caution.



Hypothetical accident at fictional NPP for illustration, output from RODOS FDMT. Showing 1 year potential dose from all pathways except ingestion

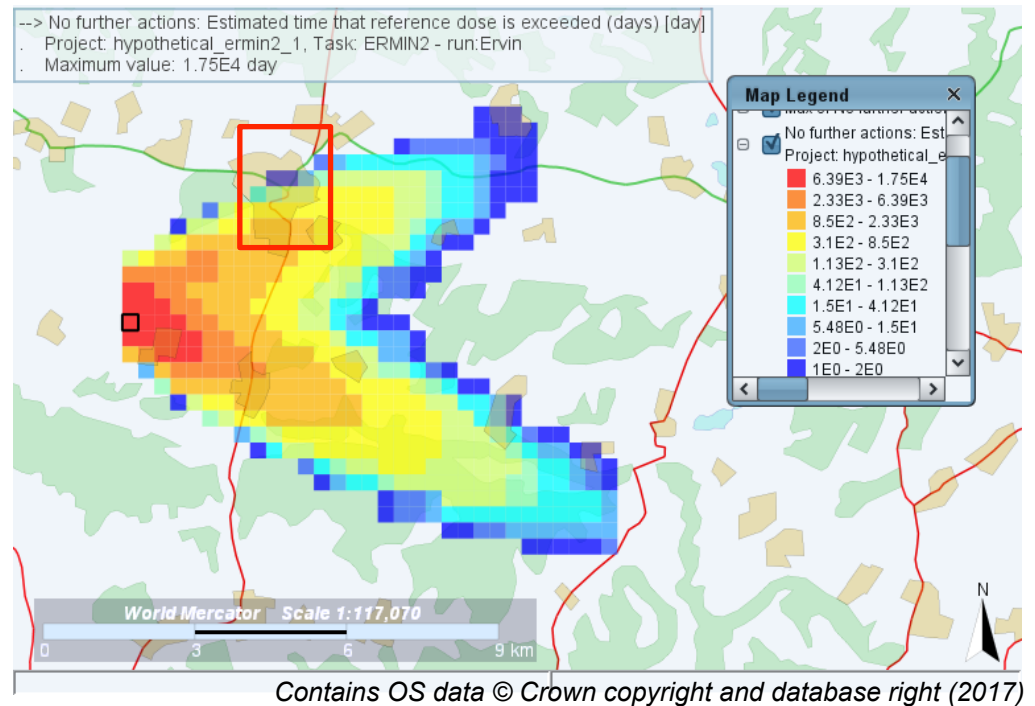
Assess Impacts

“Use data and models to assess projected doses to people living in the affected areas.” (NNEPRG 2015)

In early phase, project future doses for a simple default environment.

Apply dose criteria to assess period/duration of impact

Look at consequences of varying criteria



Hypothetical accident at fictional NPP for illustration, output from ERMIN2 shows predictions of the days that the projected dose exceeds a reference dose given as 20 mSv/y normal living (0.9 occupancy) in brick houses.

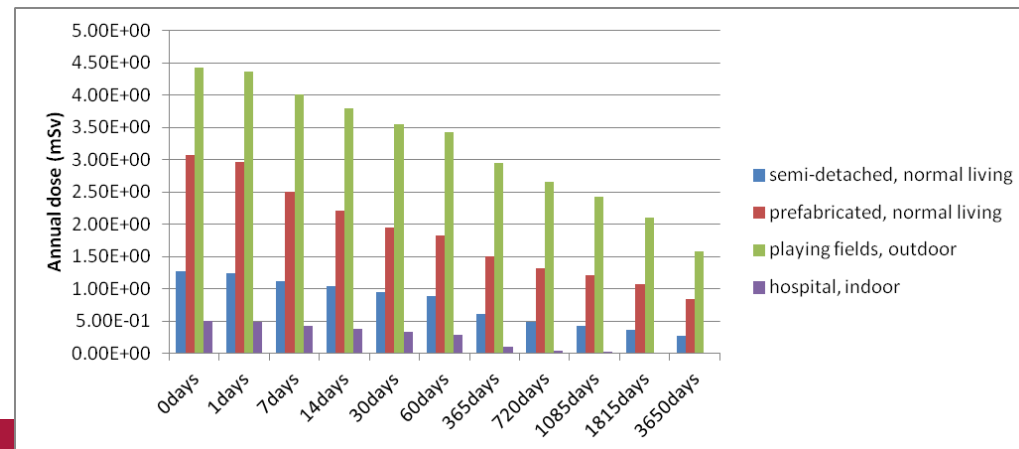
Red	>20years
Dark Orange	6-20 years
Light Orange	2-6 years
Yellow	1-2 years
Others	< 1year

Assess Impacts

“... Take account of exposure scenarios habits and prevailing environmental conditions” (NNEPRG 2015)

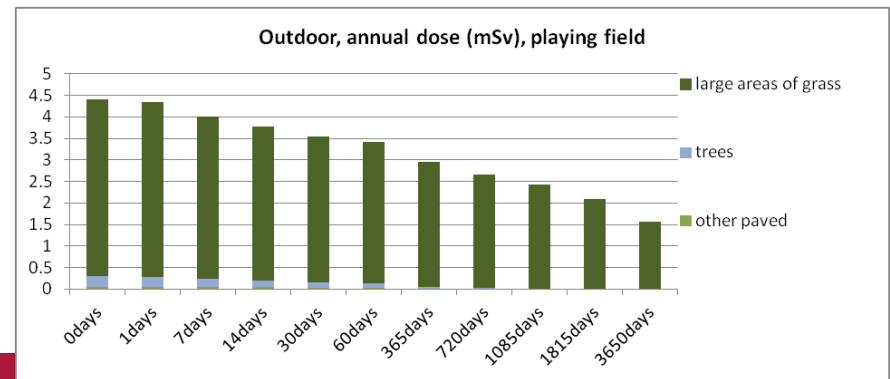
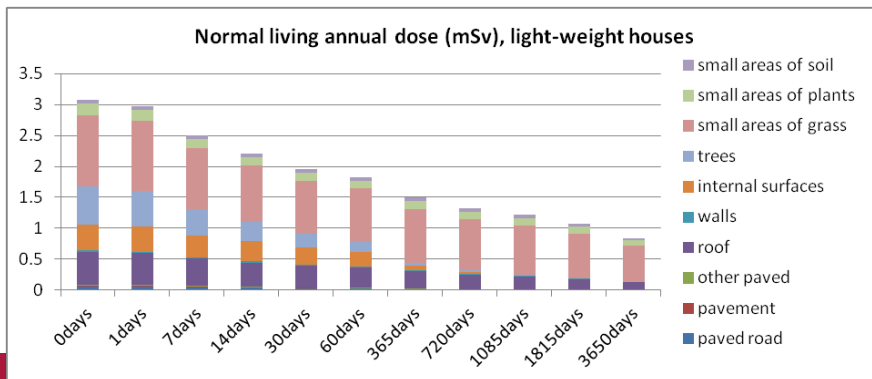
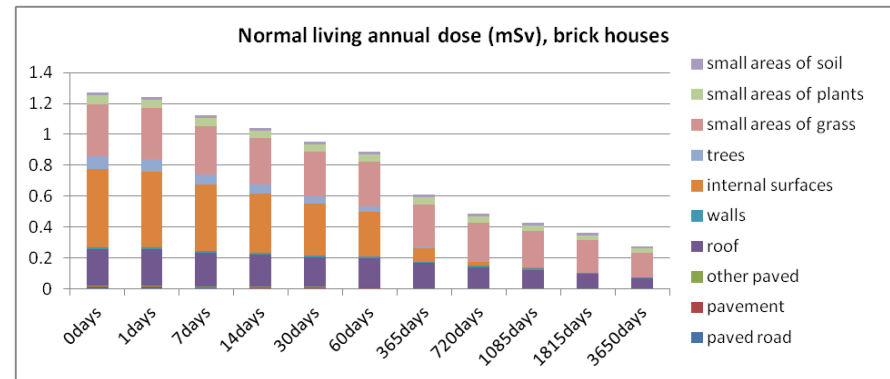
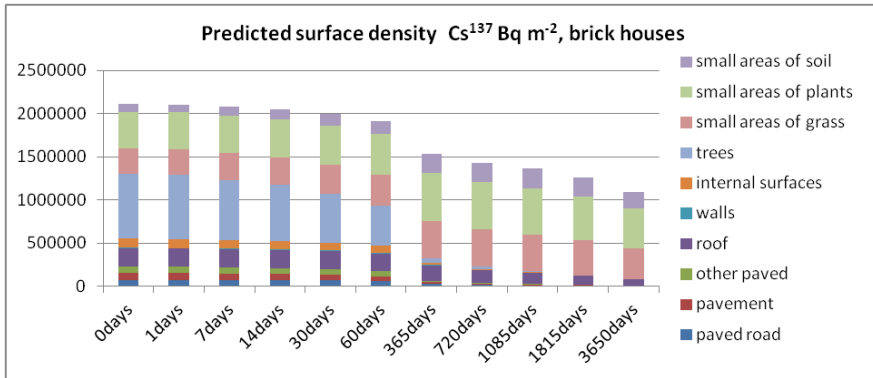


Environment
Street of detached prefabricated houses
Street of detached prefabricated houses
Street of semi-detached houses with basement
Street of semi-detached houses without basement
Street of terraced houses
Multi-storey block of flats amongst other house blocks
Multi-storey block of flats opposite parkland
Industrial site
Large open area

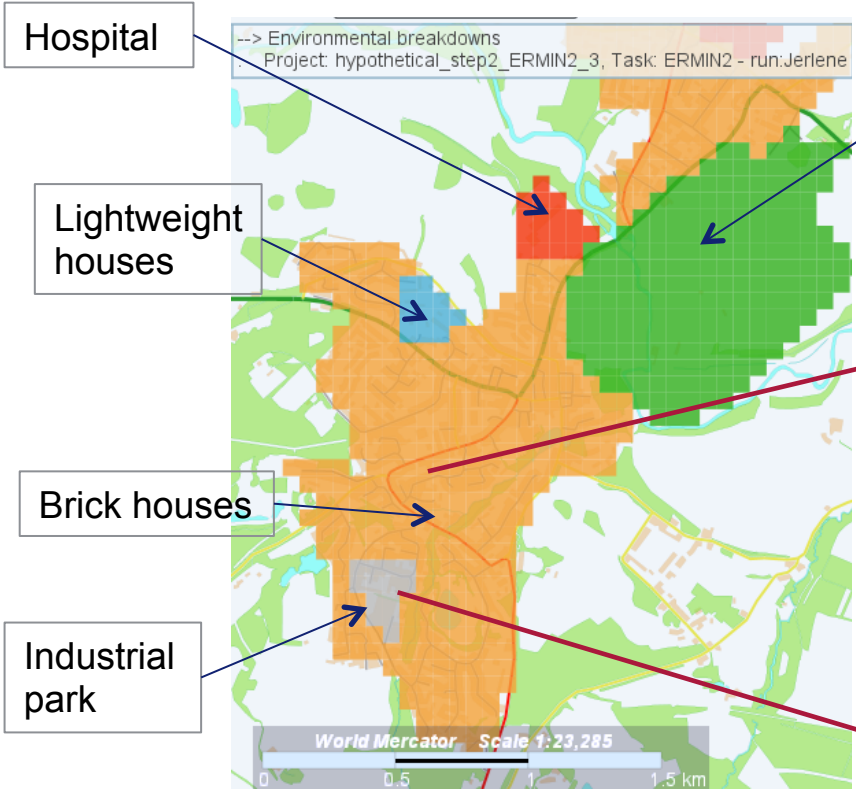


Identify goals and options

“Engage communities in establishing recovery goals – based on radiological, economic, environmental and other criteria. Agree how radiological risk will be equated with measurable radioactivity in the environment” (NNEPRG 2015)



Identify goals and options



Hospital

Lightweight houses

Brick houses

Industrial park

Playing fields

4: Roofs 1.06E-1 Sv
Found the following applicable recovery actions of 'constraints on application' type
8:Firehosing roofs; applicable after any deposition conditions; incompatibility value 0%
15:Roof brushing; incompatibility value 0%
19:Roof cleaning with pressurised hot water; incompatibility value 0%
27:Peelable coatings; incompatibility value 0%
63:Roof replacement; incompatibility value 0%
64:High pressure hosing roofs; incompatibility value 0%
32:Tie-down to buildings with vinacryl; incompatibility value 0%

8: Small area of grass 7.9E-2 Sv
Found the following applicable recovery actions of 'generally applicable' type
9:Cover with clean soil-small scale; incompatibility value 0%
11:Rotovating; incompatibility value 0%
16:Cover with asphalt-small scale; incompatibility value 0%

6: Internal surfaces 6.35E-2 Sv
Found the following applicable recovery actions of 'generally applicable' type
22:Washing interior surfaces; applicable after any deposition conditions; incompatibility value 0%

4: Roofs 2.65E-2 Sv
Found the following applicable recovery actions of 'constraints on application' type
8:Firehosing roofs; applicable after any deposition conditions; incompatibility value 0%
15:Roof brushing; incompatibility value 0%
19:Roof cleaning with pressurised hot water; incompatibility value 0%
27:Peelable coatings; incompatibility value 0%
63:Roof replacement; incompatibility value 0%
64:High pressure hosing roofs; incompatibility value 0%
32:Tie-down to buildings with vinacryl; incompatibility value 0%

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The jRODOS “Countermeasure Wizard” suggests management options for different zones

Evaluate options

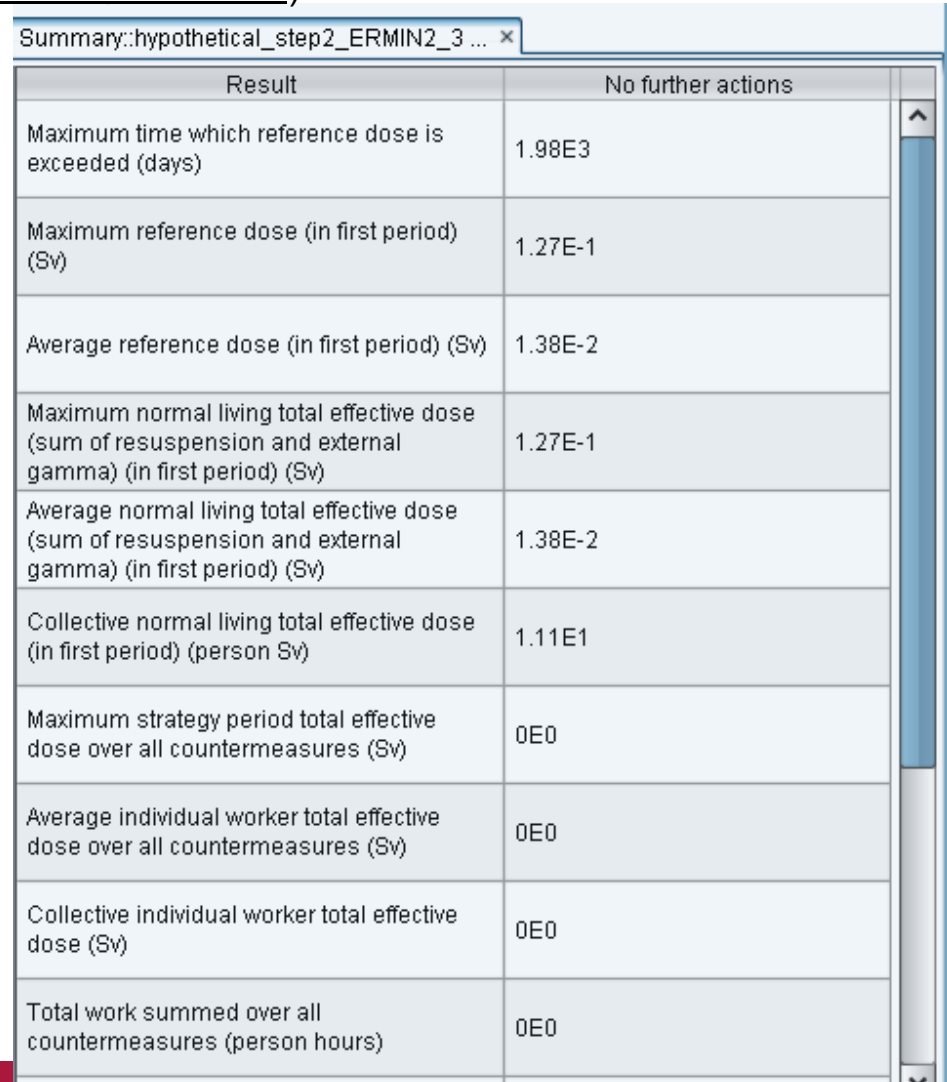
Options are put together as packages: “strategies”

User defined strategies are compared against a base line “No Further actions (NFA)” strategy.

NFA allows for options already undertaken in previous cycles of decision making

All other strategies include the NFA options

“Consider effectiveness, feasibility, capacity, time scales, constraints, waste generation, worker doses, costs, impact on society, acceptability” (NNEPRG 2015)



Result	No further actions
Maximum time which reference dose is exceeded (days)	1.98E3
Maximum reference dose (in first period) (Sv)	1.27E-1
Average reference dose (in first period) (Sv)	1.38E-2
Maximum normal living total effective dose (sum of resuspension and external gamma) (in first period) (Sv)	1.27E-1
Average normal living total effective dose (sum of resuspension and external gamma) (in first period) (Sv)	1.38E-2
Collective normal living total effective dose (in first period) (person Sv)	1.11E1
Maximum strategy period total effective dose over all countermeasures (Sv)	0E0
Average individual worker total effective dose over all countermeasures (Sv)	0E0
Collective individual worker total effective dose (Sv)	0E0
Total work summed over all countermeasures (person hours)	0E0

Evaluate options

Console messages::hypothetical_step2 ... Summary::hypothetical_step2_ERMIN2_3 ... x

Map ERMIN UI::hypothetical_step2_ERMIN2_...

Results

- Reference dose (RD) F T
 - Max time RD is exceeded
 - Population in area RD is exce...
 - Total area RD is exceeded
 - Maximum reference dose
 - Average reference dose
- Maximum normal living doses F T S
 - Total effective
 - External gamma effective
 - Resuspension effective
 - External beta skin
- Maximum outdoor doses
- Maximum indoor doses
- Average normal living doses F T S
 - Total effective
 - External gamma effective
 - Resuspension effective
 - External beta skin
- Average outdoor doses
- Average indoor doses
 - Collective normal living total effective
- Countermeasure data A C

Result	No further actions
Maximum time which reference dose is exceeded (days)	1.98E3
Total area where the reference dose is exceeded (km ²)	<p>Days after deposition</p>
Average normal living external gamma effective dose by surface (Sv)	<p>Days after deposition</p> <p><i>Legend on the left under Surfaces section</i></p>
Collective normal living total effective dose (in first period) (person Sv)	1.12E1

Evaluate options

The consequences of proposed strategies can be evaluated and compared

Example: low impact strategy

Init Area of Interest Environment Breakdowns Early Countermeasures Recovery Countermeasures Countermeasure Wizard

Countermeasure Strategies

No further actions
Low impact strategy

Add Delete Copy Freeze

CM Strategy: Low impact strategy

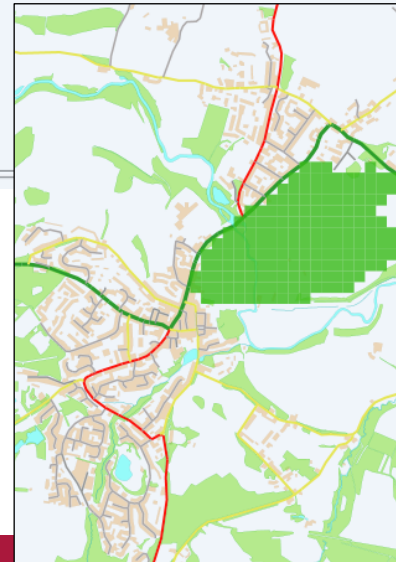
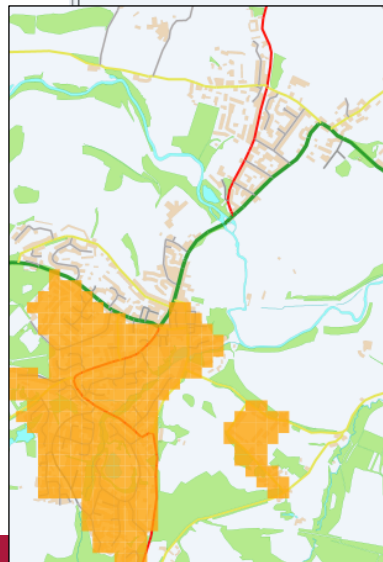
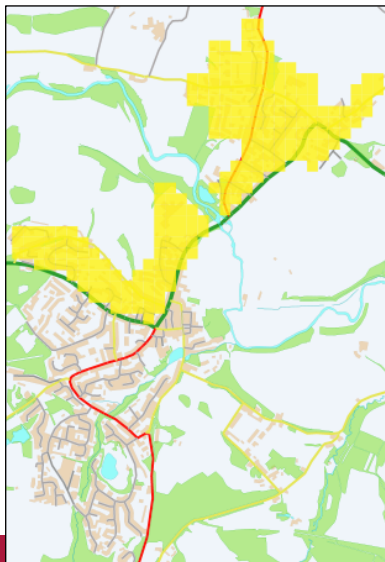
zone1 (grass cutting)
Zone2 (turf rem and
Zone 3 (playing fields)

Add Delete Draw

Countermeasures for Countermeasure Zone: Zone2 (turf rem and high pres all paved)

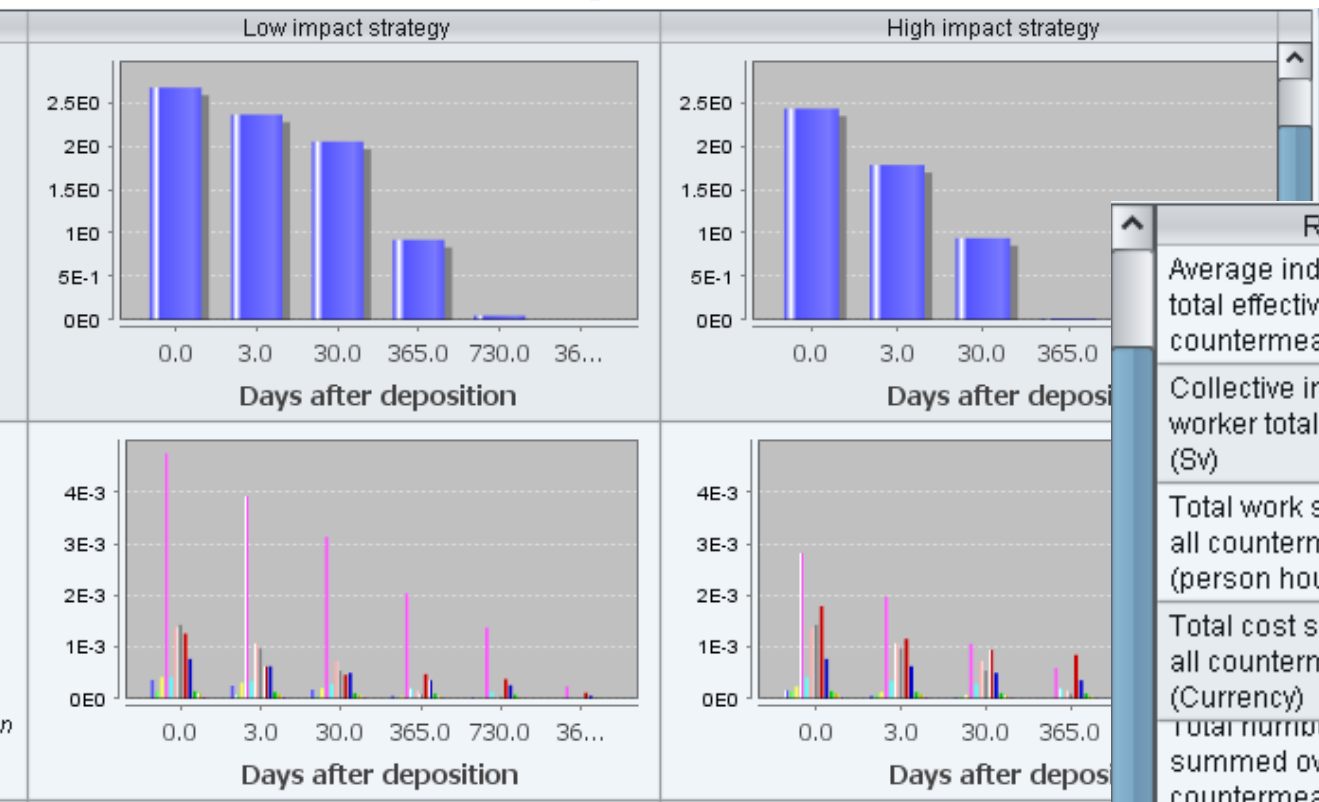
Add Delete Table No further actions <= 3.0 days <= Other strateg

Option	Surface	Start (day)	End (day)	PPE	Re
5:Turf harvesting-small scale	8:Mowable grass	10.0	20.0	<input checked="" type="checkbox"/>	
26:High pressure hosing paved	1:Paved road	10.0	20.0	<input type="checkbox"/>	
26:High pressure hosing paved	2:Paved pavement	10.0	20.0	<input type="checkbox"/>	
26:High pressure hosing paved	3:Paved other	10.0	20.0	<input type="checkbox"/>	



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Evaluate options



Result	Low impact...	High impact ...
Average individual worker total effective dose over all countermeasures (Sv)	6.24E-3	3.55E-3
Collective individual worker total effective dose (Sv)	1.25E1	3.8E1
Total work summed over all countermeasures (person hours)	1.07E5	2.28E6
Total cost summed over all countermeasures (Currency)	5.09E6	8.01E7
Total numbers of workers summed over all countermeasures (person)	2E3	1.07E4
Total waste amount summed over all countermeasures (kg)	4.39E7	7.88E7
Maximum beta gamma concentration in waste (Bq kg)	8.05E8	2.57E9

Summary/conclusions

Modelling tools do have a place, especially early on when data is sparse, but also throughout for projecting consequences of proposed strategies

Requirements:

Operational (run-times short, user input requirements low, easy to use)

Do not prescribe the decision-making process, but:

- allows the user to frame the problem according to current needs (e.g. scale, available data, priorities etc)

- recognise the iteration and feedbacks of decision making

- allows the user to take what they need and apply it to the wider decision-making framework (information must be easily extracted)

- produces information that is usable (appropriate to the current situation, understandable, complements other information)

