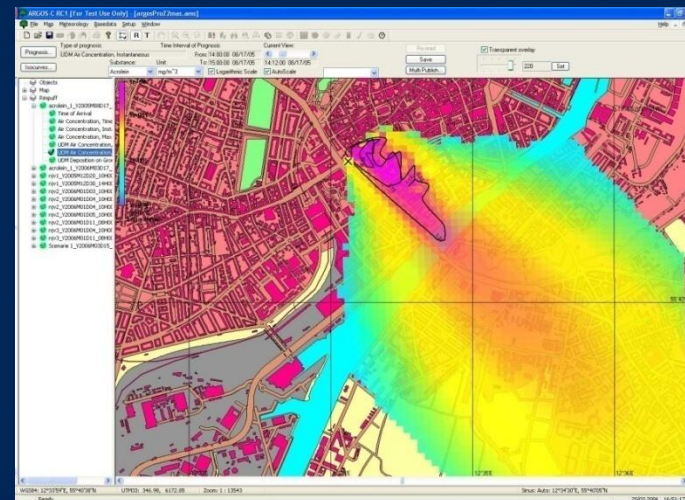


# Update on elements and methodologies used in the Nordic countries in decision support.

Nordic perspectives of Fukushima: Where are we now and where do we go?

Joint NKS-R and NKS-B Seminar,  
Stockholm, 12-13 January 2016

Steen Hoe  
Nuclear Division, DEMA

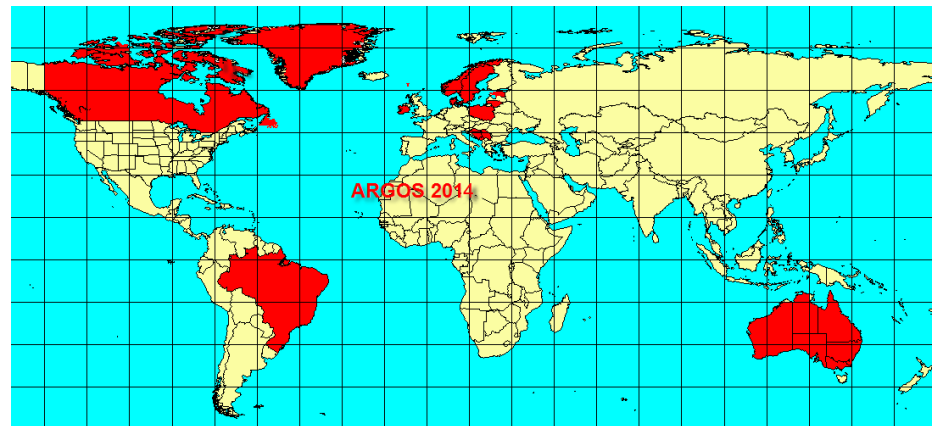


Contact: Hoe@brs.dk

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# ARGOS CRN

- Decision Support System developed since 1993
- Maintained by the ARGOS Consortium (operational Emergency Organisation and PDC-ARGOS) and used worldwide)
- Models from research organisation supported by EU Research programs (FP5,6 and 7) and the ARGOS Countries

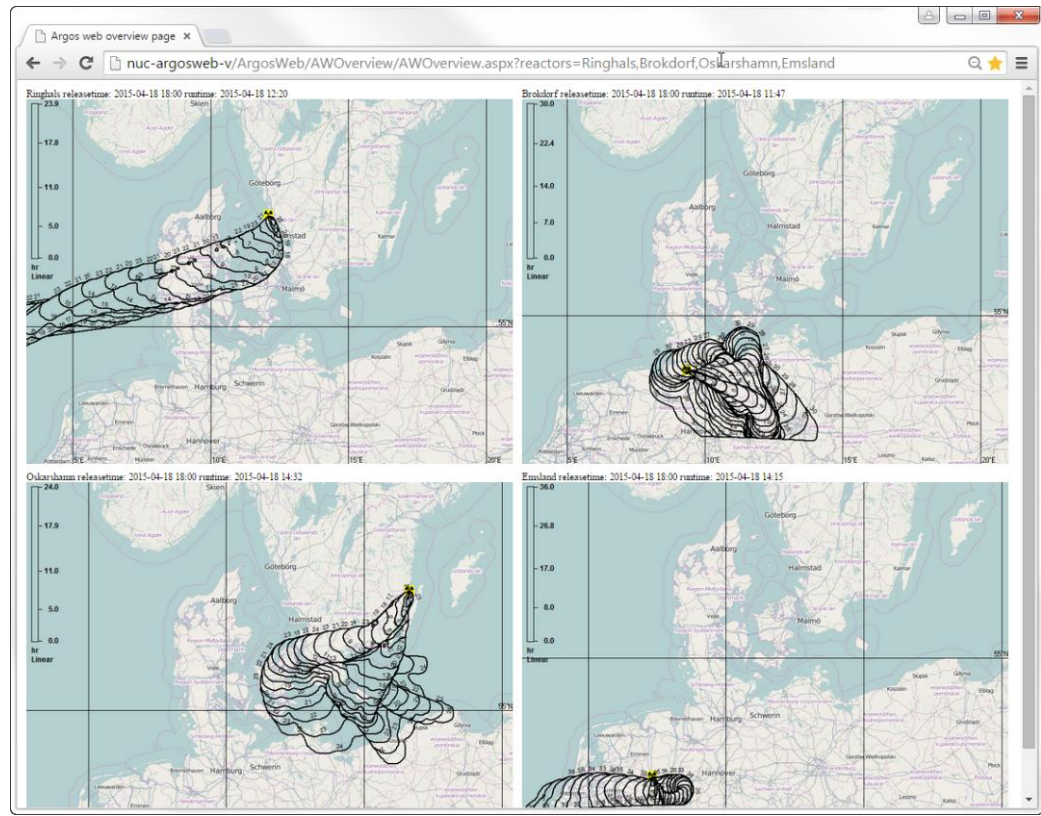


# Danish implementation

- **One** installation for R,N and C
- **Identical** metrological data for R, N and C with worldwide meteorological data access.
- **Identical** GIS data – buildings (Denmark) and populations
- **Identical** meso-scale dispersion model (RIMPUFF) for R,N and C – Special long range models for N (R)
- **Identical** Urban dispersion (URD) for R and C
- **Identical** Food- and Urban dose model for R and N
- Special Chemical source- and consequence model
- Special monitoring data implementation for R and N

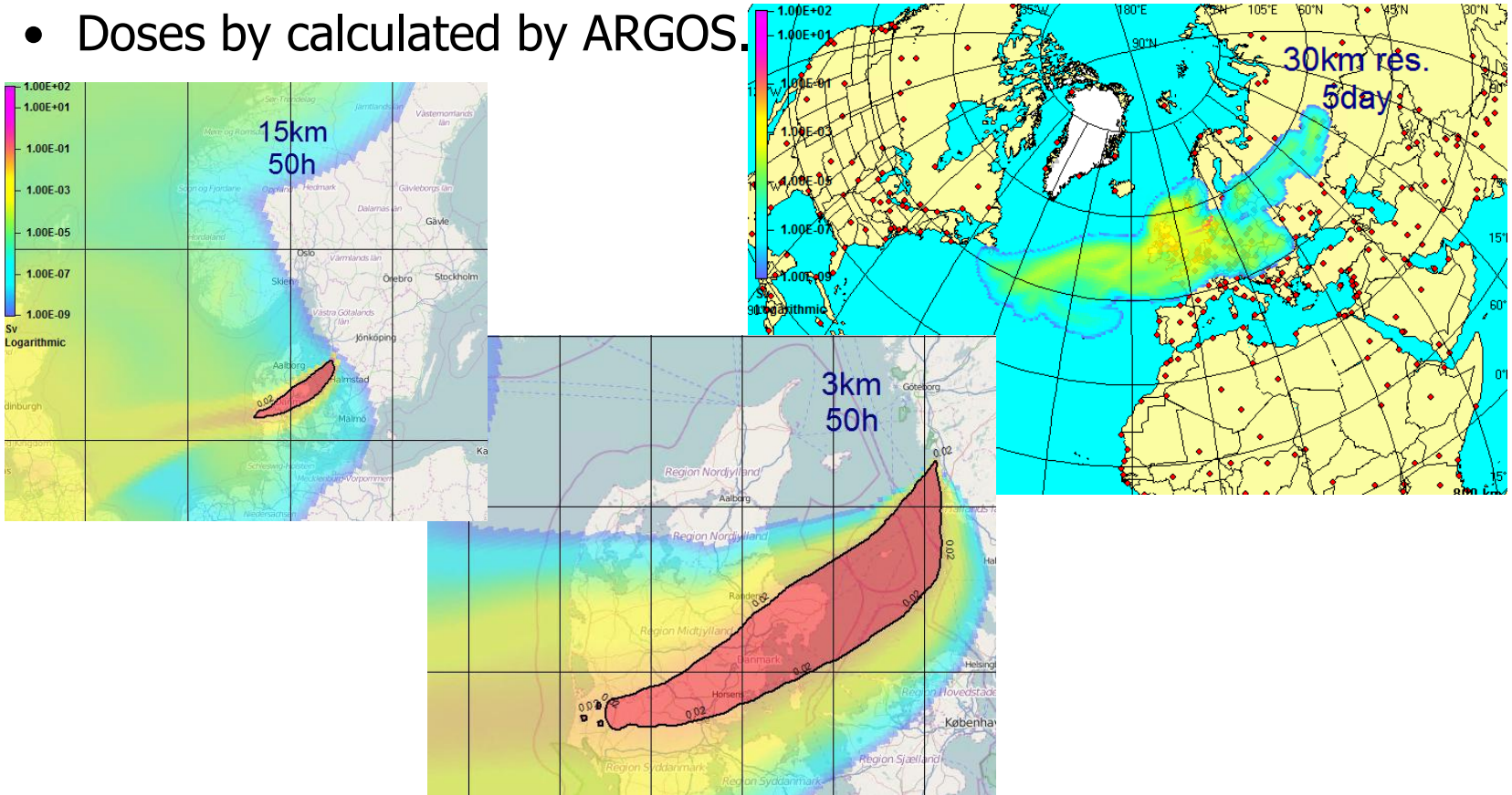
# Release, Pre-release and Planning phase

- Automated Dispersion Calculation, time of arrival for closest NPP calculated 4 times daily.
- Automated Dispersion Calculation for urban Areas for R and C



# Release, Pre-release and Planning phase N

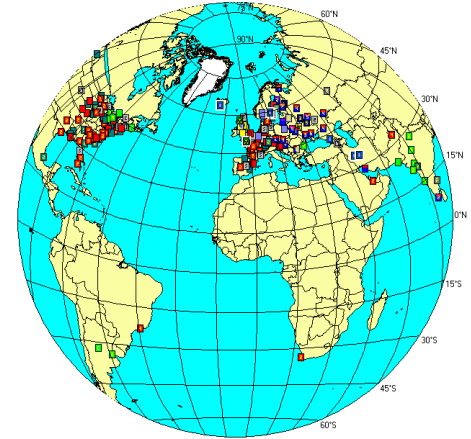
- DERMA: Global Long Range model with horizontal resolution from 3km to 30 km – the 3km model also for R.
- Doses by calculated by ARGOS.





# Release (R,N), Pre-release phase (N) - Source

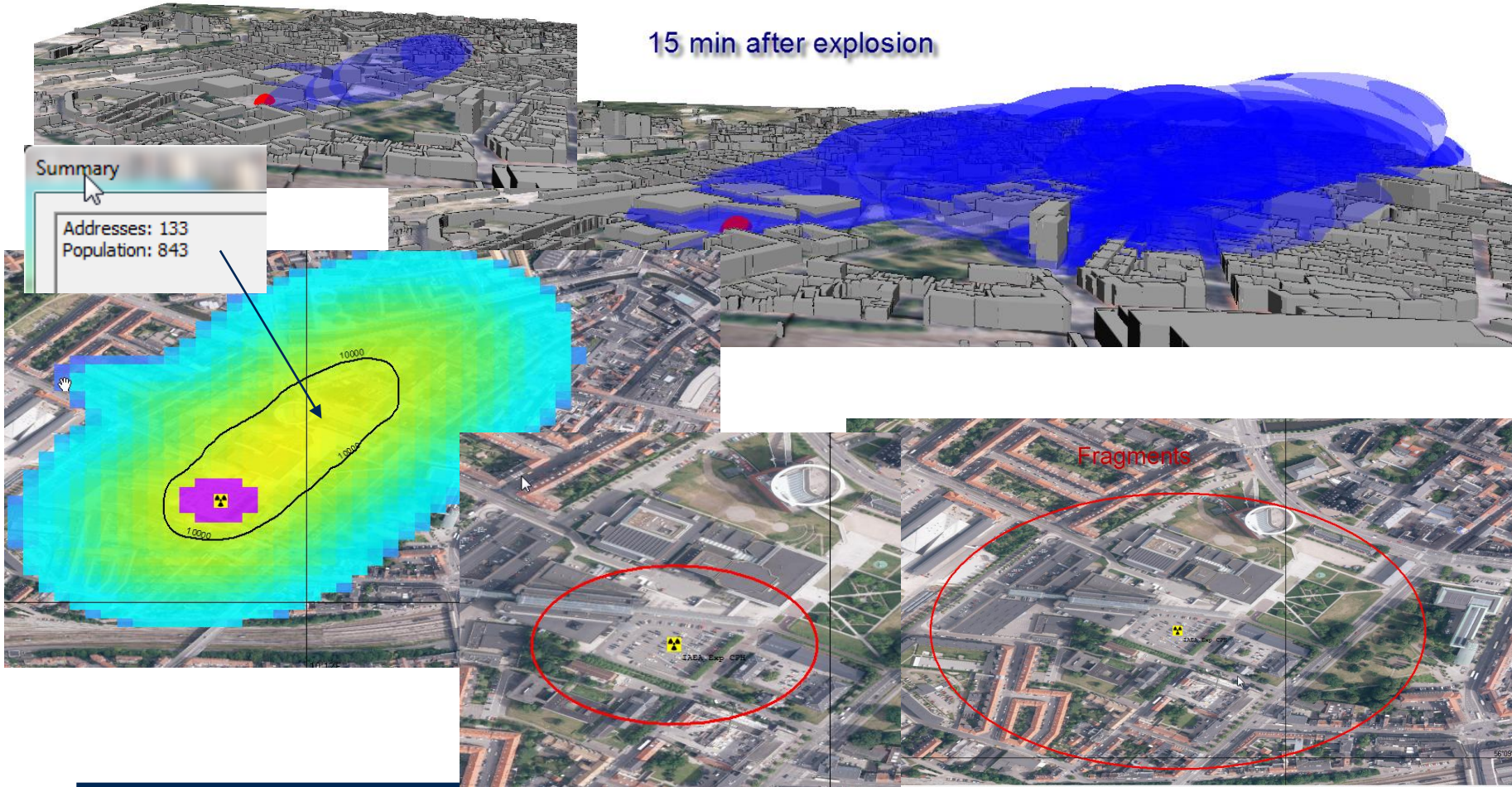
- RIMPUFF: Dispersion Calculation, with Precipitation from RADAR if possible in
  - Source Term for Reactors from ARGOS DB, multiple sources possible.
  - Source Terms for N multiple point sources.
- URD model also includes “Dirty Bomb” modelling in form of predefined initial shapes (puff column) and initial deposition
- URD will also create a potential damage zone before the actual run



# Urban Dispersion

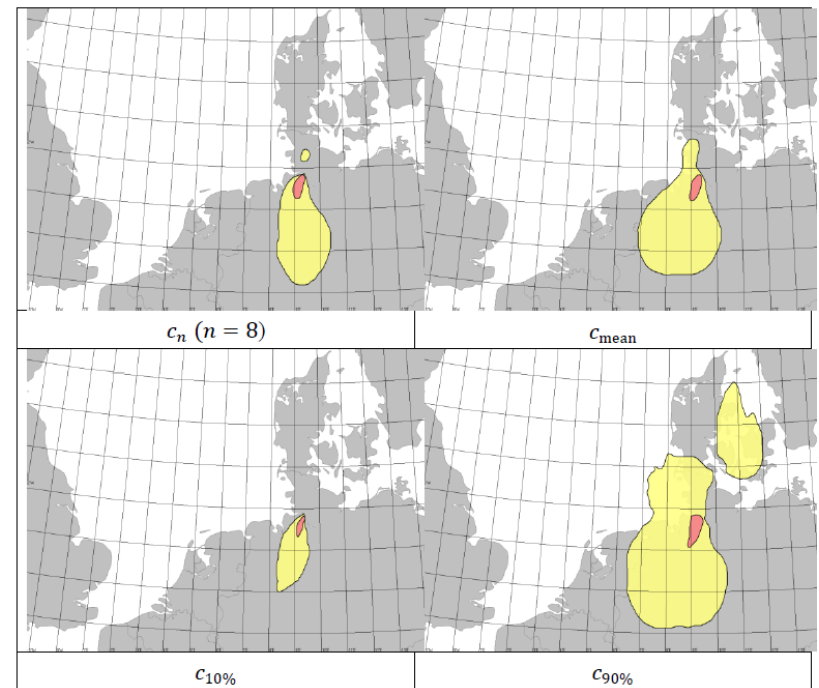
1 min after explosion

15 min after explosion



# Uncertainty in numerical weather prediction (NWP)

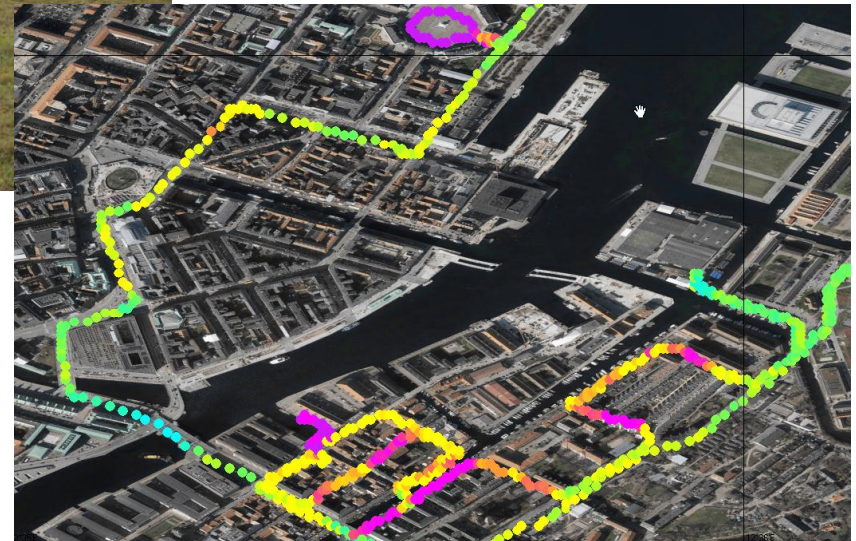
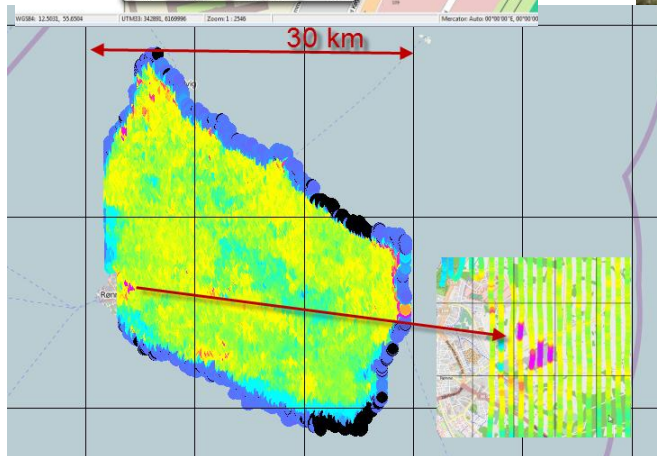
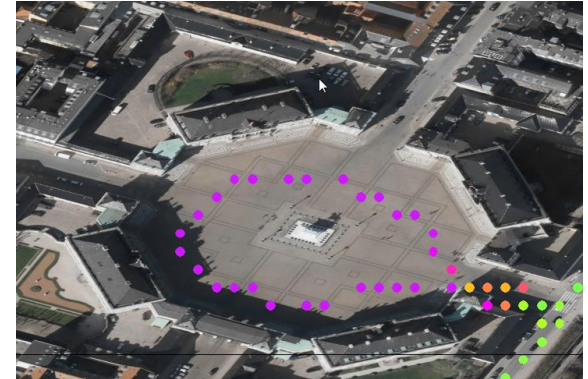
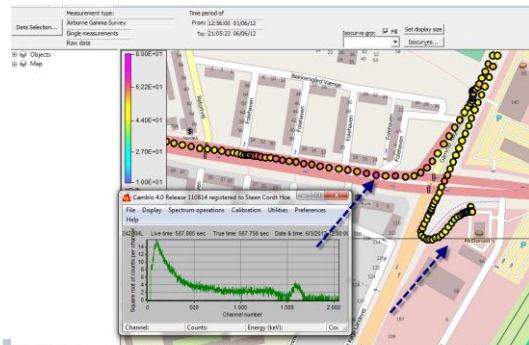
- Presentation of statistical data
- 25 dispersion calculations resulting in a statistical envelope.
- *Not physical Correct*
- NKS(.org) financed project
- Fukushima test case.





# Monitoring after plume for model use

- **Nuclide specific deposition** input from AGS and CGS system in raw 4242 format,
- Dose rate can be converted with a Nuclide Vector

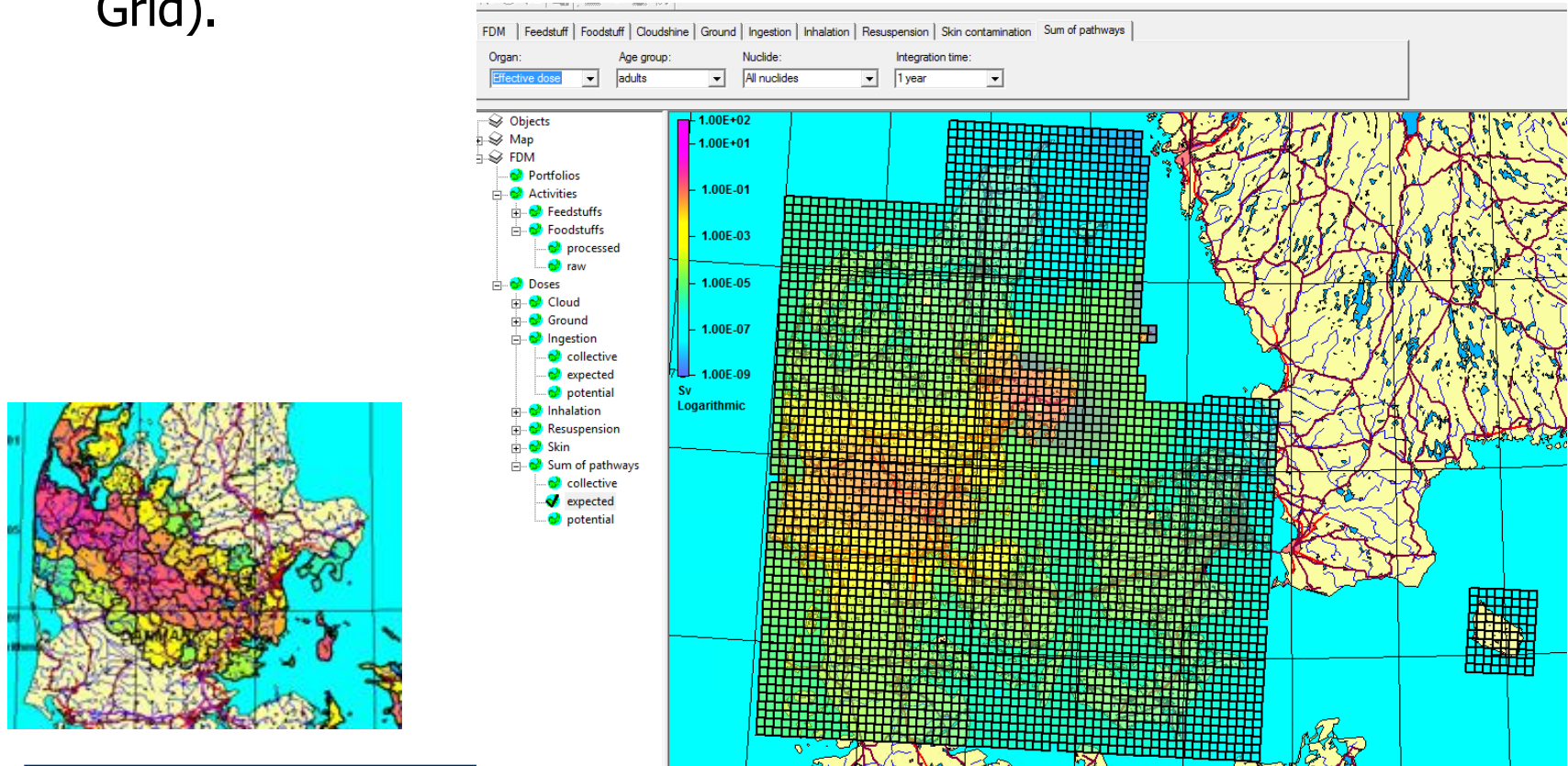


# Dose and Countermeasure modelling

- Danish Implementation
  - Urban dose modelling with ERMIN on 100m grid
  - Food Dose Modelling with AgriCP on 5 km Grid

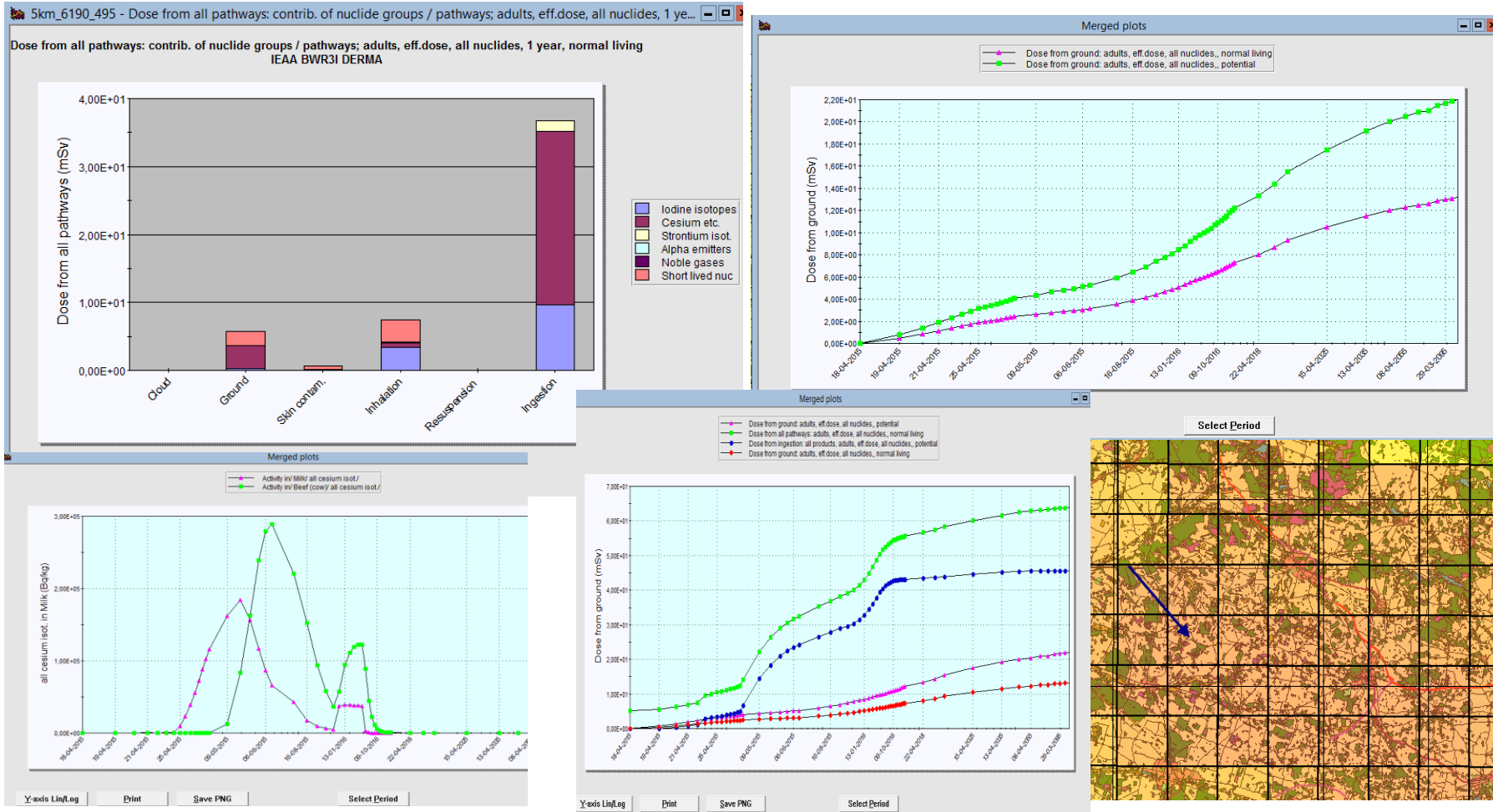
# Food Dose and Countermeasure Modelling

- First version of the implementation was based on municipalities but they became too large. In 2015 the basis was changed to 5 km grid (part of the Danish National Grid).



# Food Dose Modelling

- ARGOS will list areas where the max food levels is exceeded



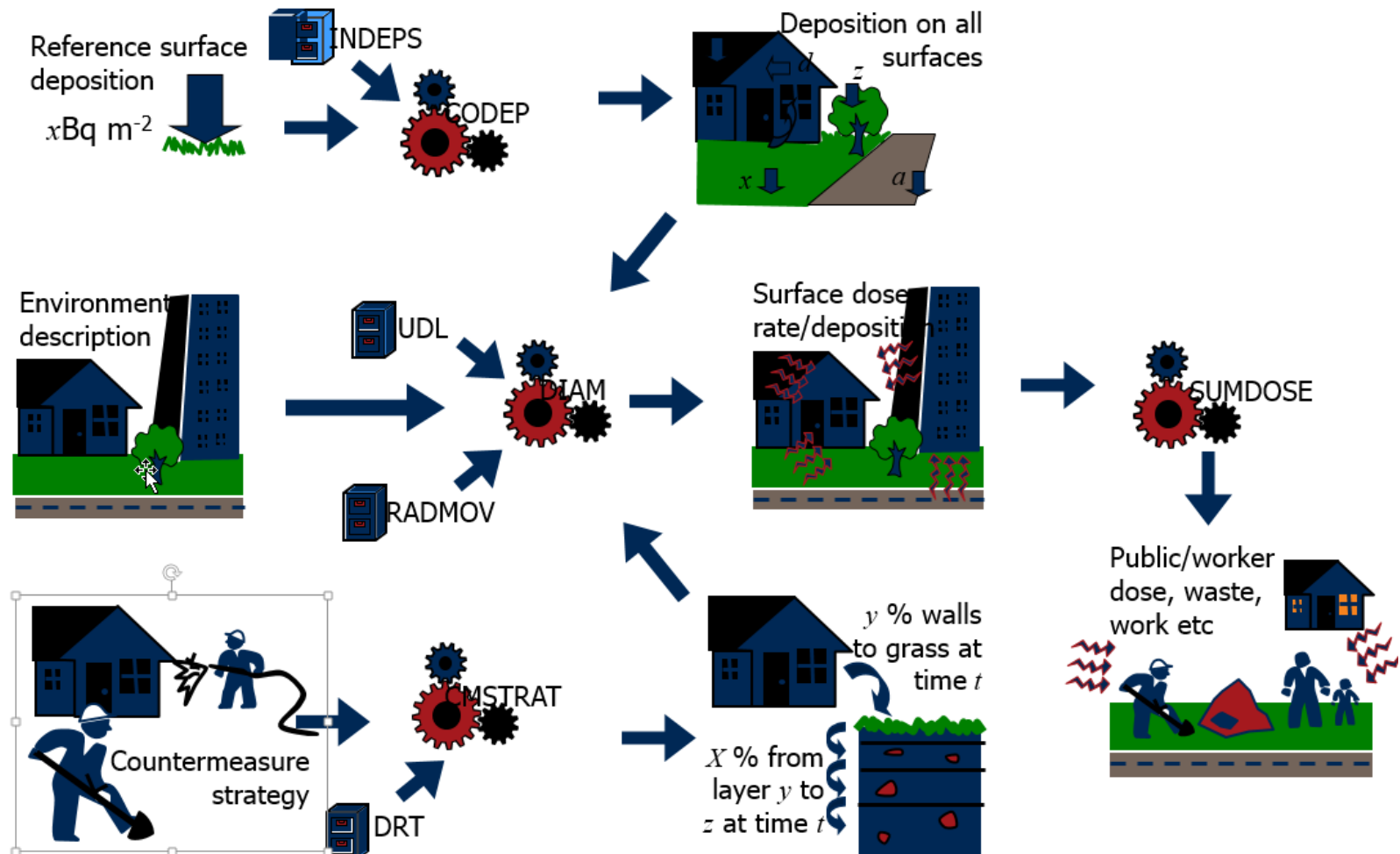


# Urban Dose and Countermeasure modelling

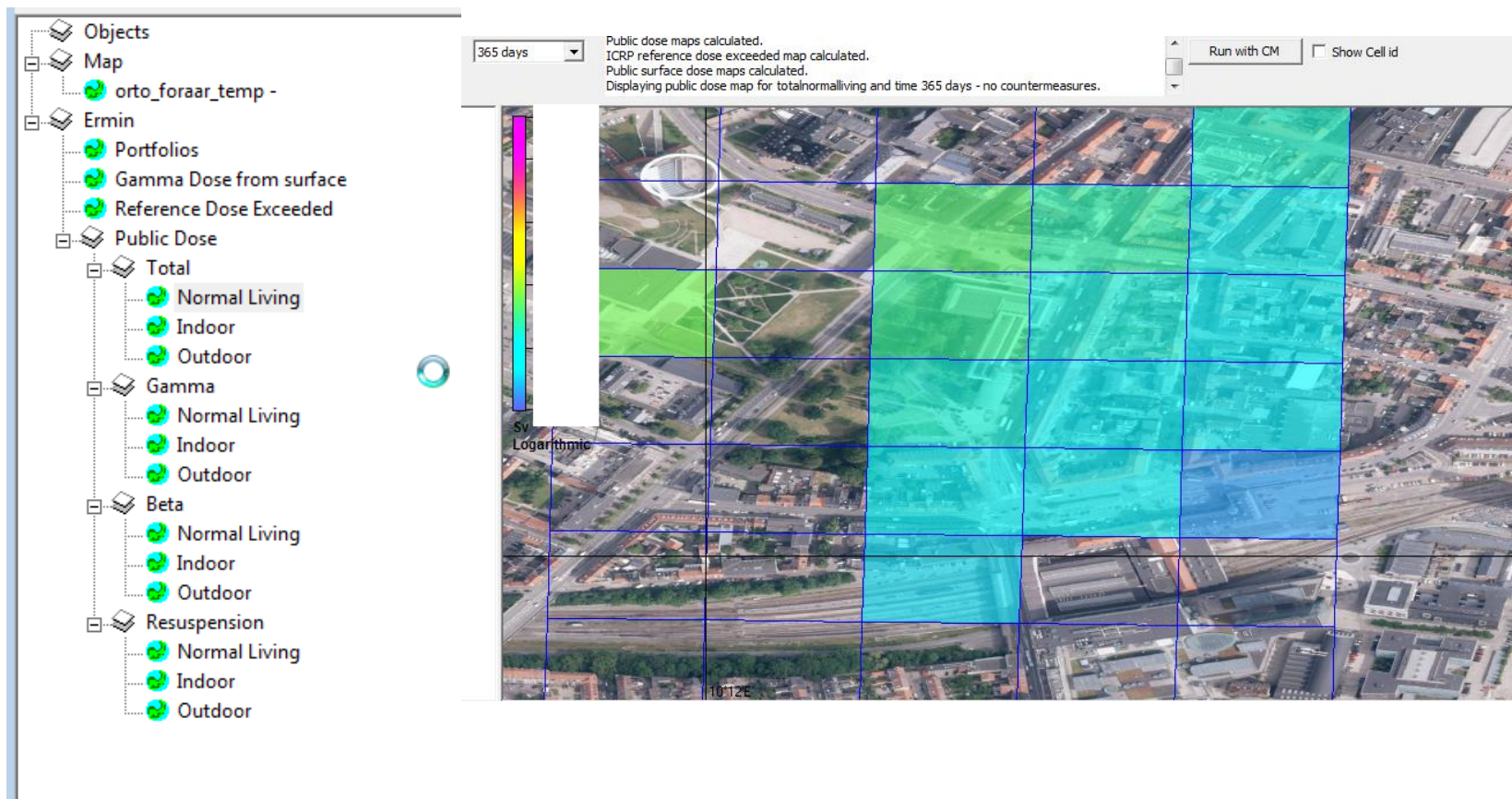
- ERMIN (The European Model for Inhabited Areas)
- Input from Atmospheric dispersion or monitoring
- Dose calculation, counter measures
- Waste, Worker dose



# ERMIN model description



# Dose and Countermeasure modelling in URBAN areas – ERMIN display



# Countermeasure strategy for URBAN or Food

## **Countermeasures food:**

- Grass Cutting.
- Food ban.
- Evacuation.
- .....

## **Countermeasures URBAN:**

- Evacuation
- Sheltering
- Tie Down
- Soil removal
- .....

## Countermeasure Packages

### **Package A**

Countermeasure X from time t1AX to t2AX  
Countermeasure Y from time t1AY to t2AY

### **Package B**

Countermeasure X from time t1BX to t2BX  
Countermeasure Z from time t1BZ to t2BZ

## Portfolio

### Dose Implementation levels

#### Level E1 to E2

Package A  
Package B  
Package C  
Package D

#### Level E2 to E3

Package A  
Package B  
Package C  
Package F

#### Level E3 to E4

Package C  
Package D  
Package G

Outputs to VISA

## **Strategy:**

Combination of Countermeasure Packages from the portfolio  
(exactly 1 Package from every dose interval)



# National Exercise "Krisøv" November 2016

- "Krisøv" exercise every second year.
- 2013 Cyber attach
- 2015 Nuclear accident
- Command post - not a "real" Nuclear exercise - for testing the national crisis plan.
- The Nuclear accident plan is a sub-plan of the main plan, **first test**

# National Danish Exercise (Krisøv )November 2016

## Ministerier

Statsministeriet  
Forsvarsministeriet  
Justitsministeriet  
Udenrigsministeriet  
Erhvervs- og Vækstministeriet  
Energi-, Forsynings- og Klimaministeriet  
Miljø- og Fødevareministeriet  
Sundheds- og Ældreministeriet

## Styrelser

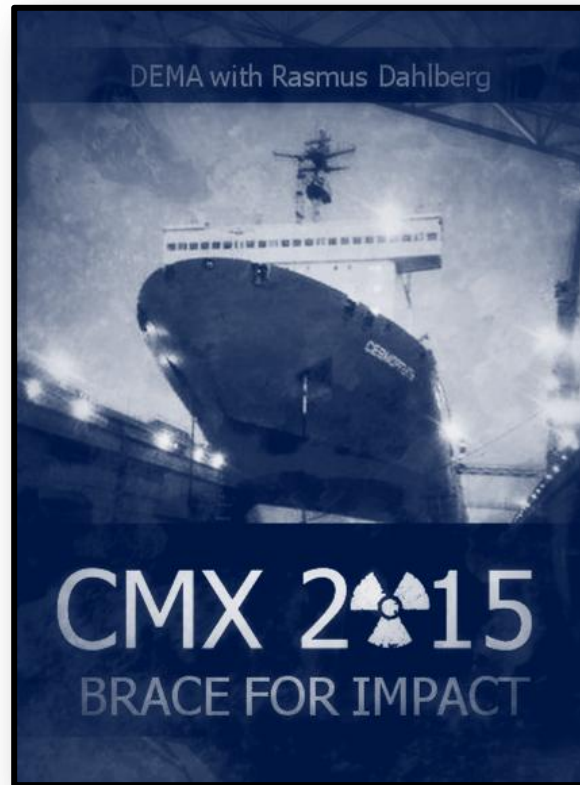
Rigspolitiet  
Beredskabsstyrelsen  
Politiets Efterretningstjeneste  
Forsvarets Efterretningstjeneste  
Center for Cybersikkerhed  
Sundhedsstyrelsen  
Værnsfælles Forsvarskommando  
Energistyrelsen  
Fødevarestyrelsen  
Søfartsstyrelsen  
Geodatastyrelsen  
Miljøstyrelsen  
NaturErhvervsstyrelsen  
Naturstyrelsen  
Trafikstyrelsen  
Vejdirektoratet  
Banedanmark  
Østjyllands Politi  
Region Midtjylland  
DMI

## Øvrige aktører

DR  
Ritzau  
Den britiske ambassade  
Den norske ambassade  
Den svenske ambassade  
Den australske ambassade

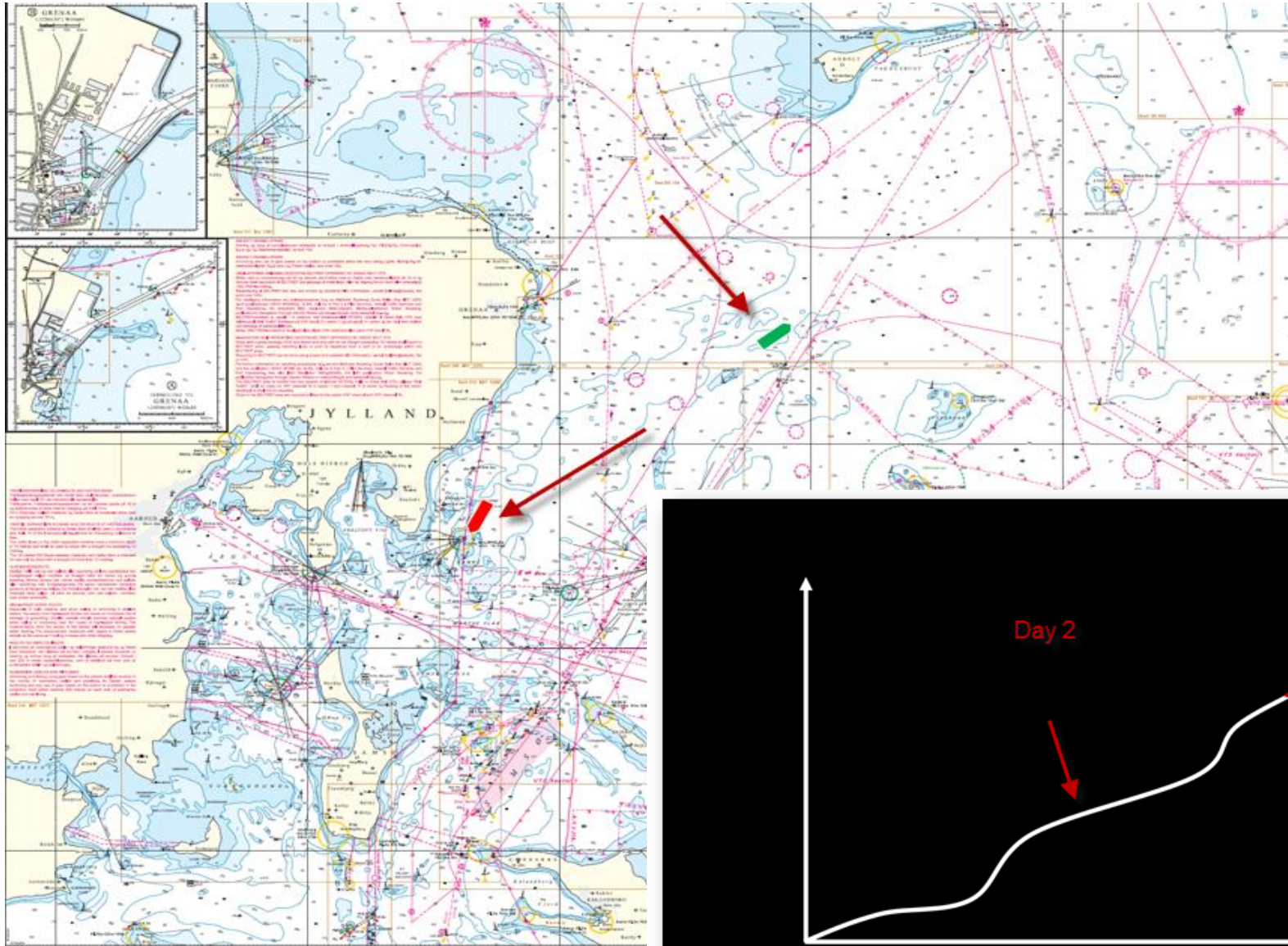


# National Exercise "Krisøv", the scenario



- Collision between the nuclear propelled Russian 'Sevmorput' and a Danish ship in passing Denmark.
- 'Sevmorput' was severely damaged and put on ground 10 km offshore.
- Damaged reactors with a late LOCA.
- Possible large release of radioactivity from 'Sevmorput'

# National Exercise "Krisøv" the scenario 2

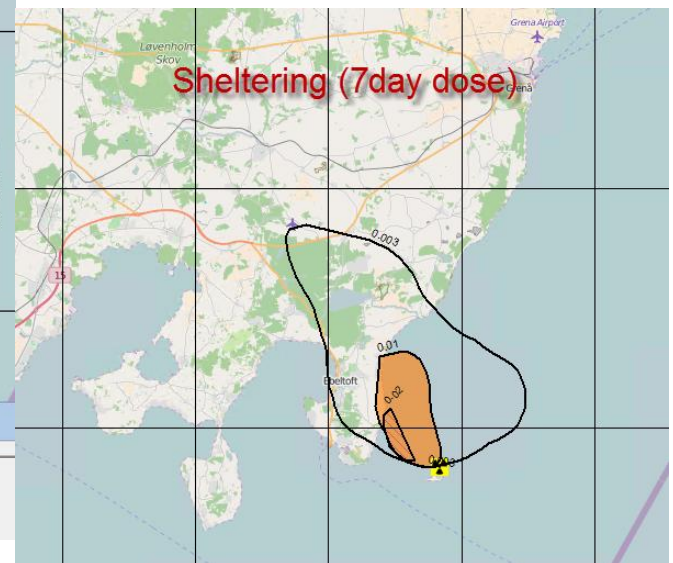
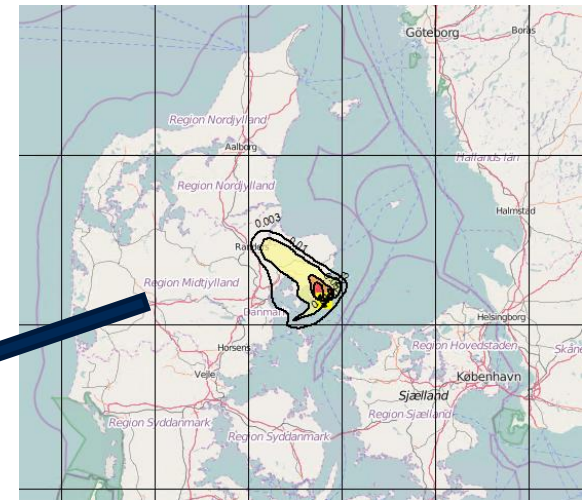
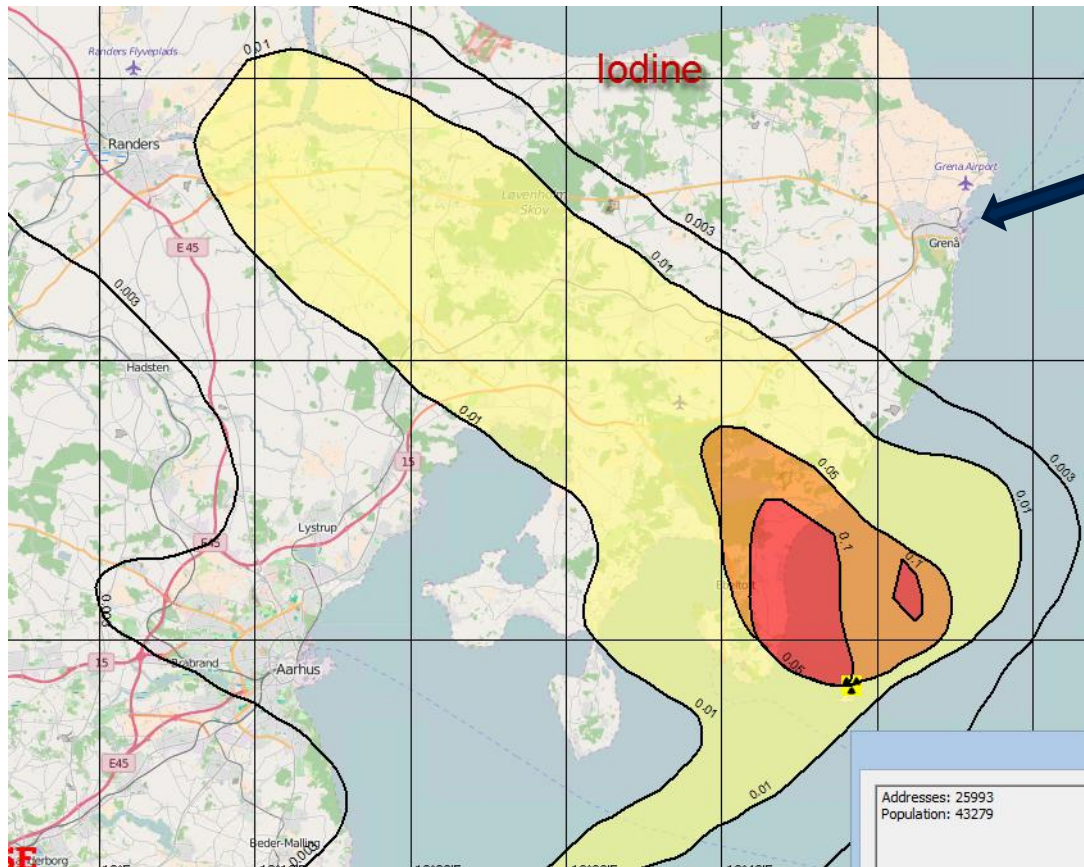




# National Exercise "Krisøv" the source term

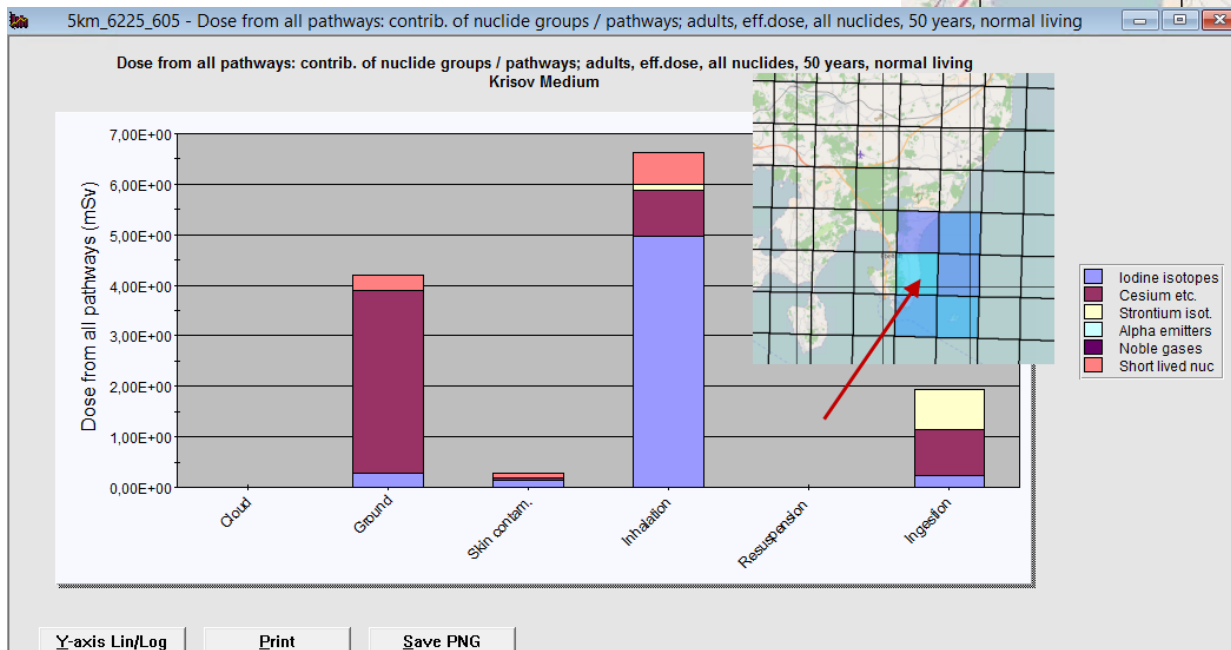
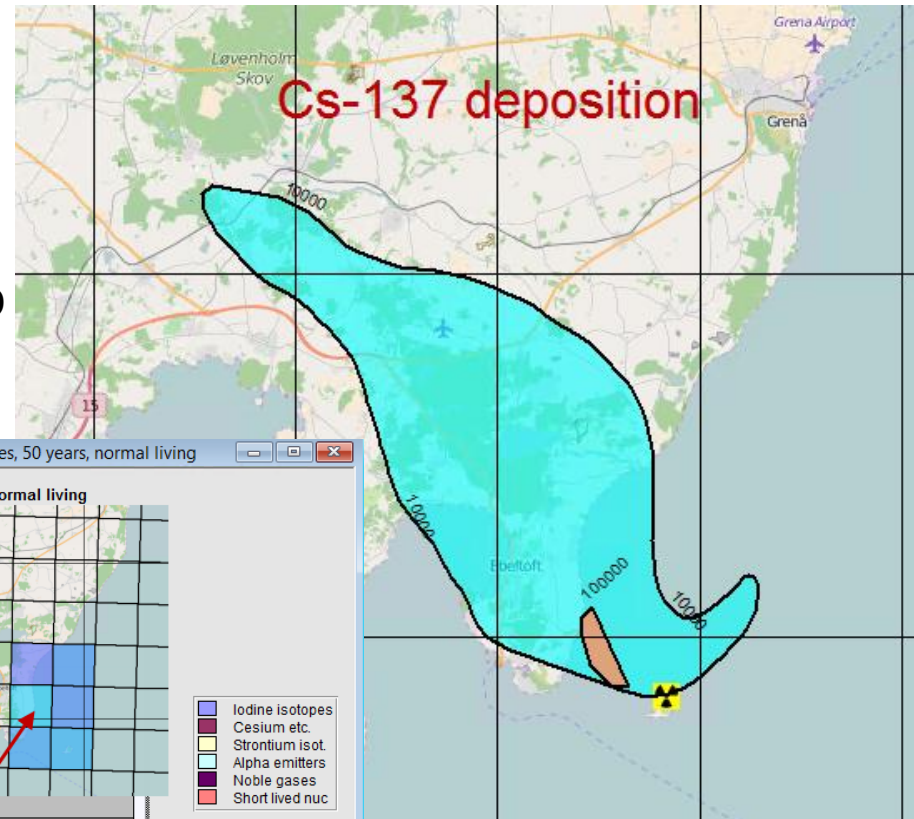
- The source terms based on VVER scaled to fit the thermal effect.
  - Low: 10 h- 30 %Xe...., 0,2% I, 0,1% Cs.....
  - **Medium:3h - 80% Xe , 8% I, 4% Cs .....**
  - High:1.5 h -80% Xe, 20% I, 20% Cs.....

# National Exercise "Krisøv" results



# National Exercise "Krisøv" results

- Low deposition – no rain
- Food chain – monitor food the next year.
- Potential acute radiation syndrome up to 500m from the ship





For experts

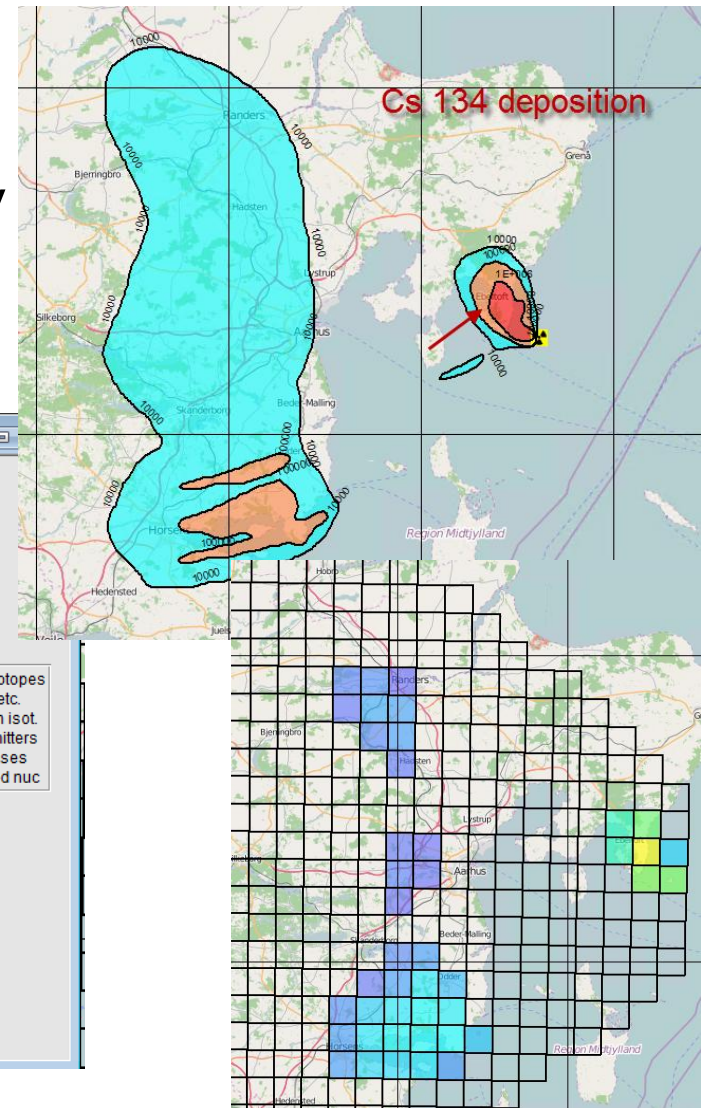
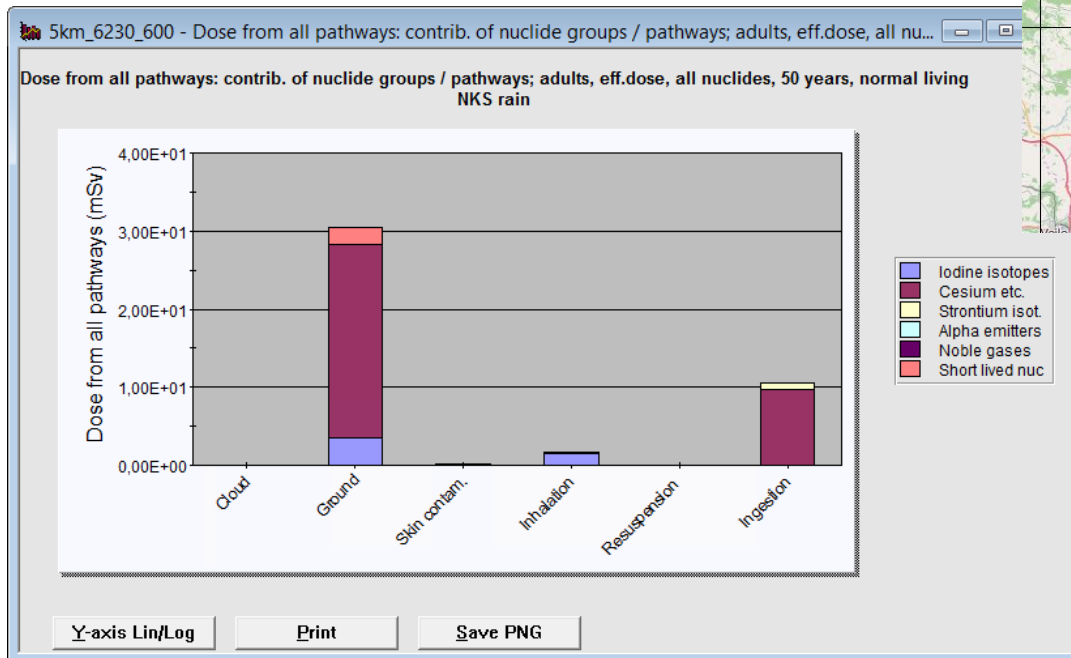
Free publication

For decision makers



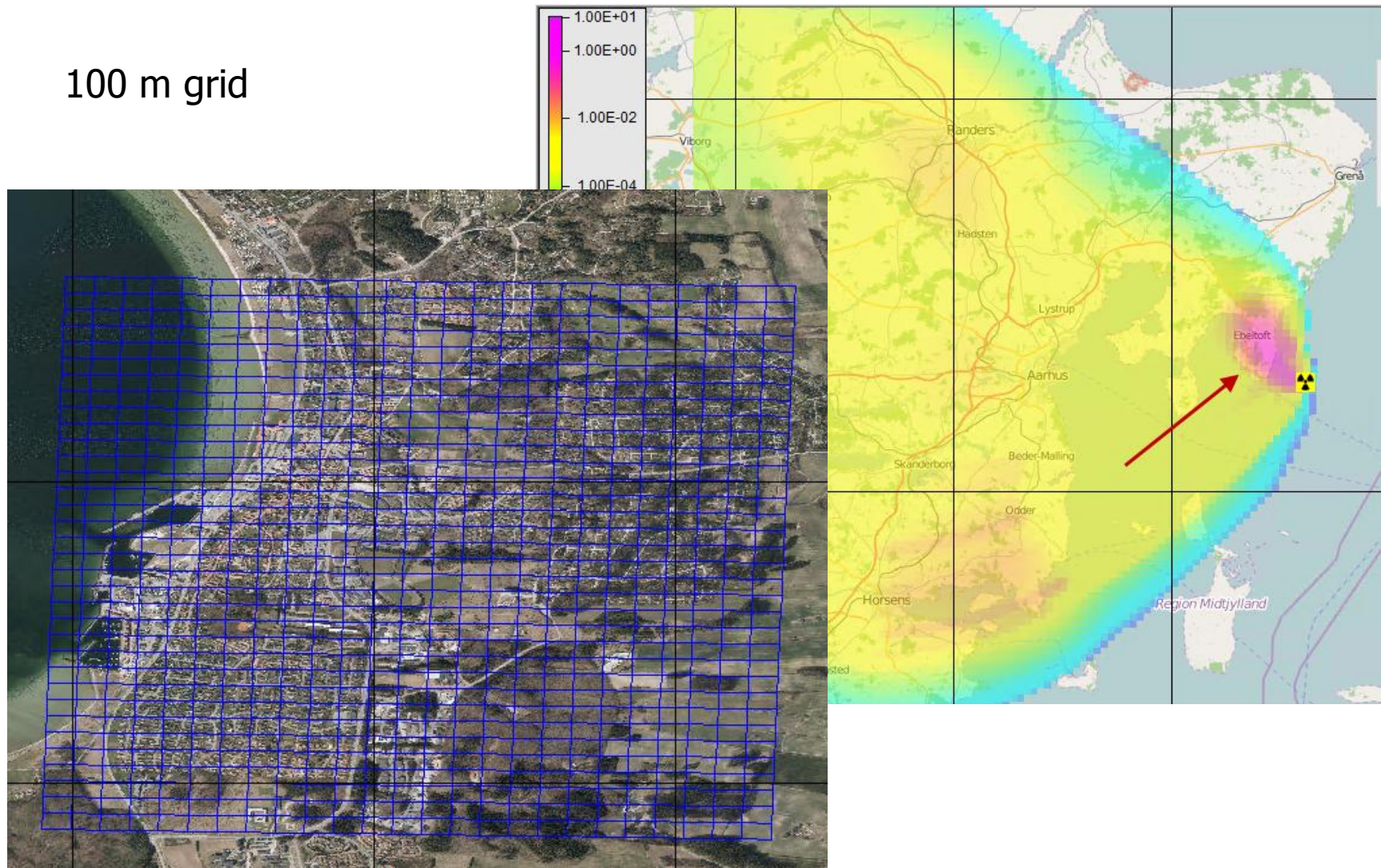
# 2 Hours **rain** added with release 2 h later

- High deposition – MBq range
- Intervention levels exceeded in the city Grenå



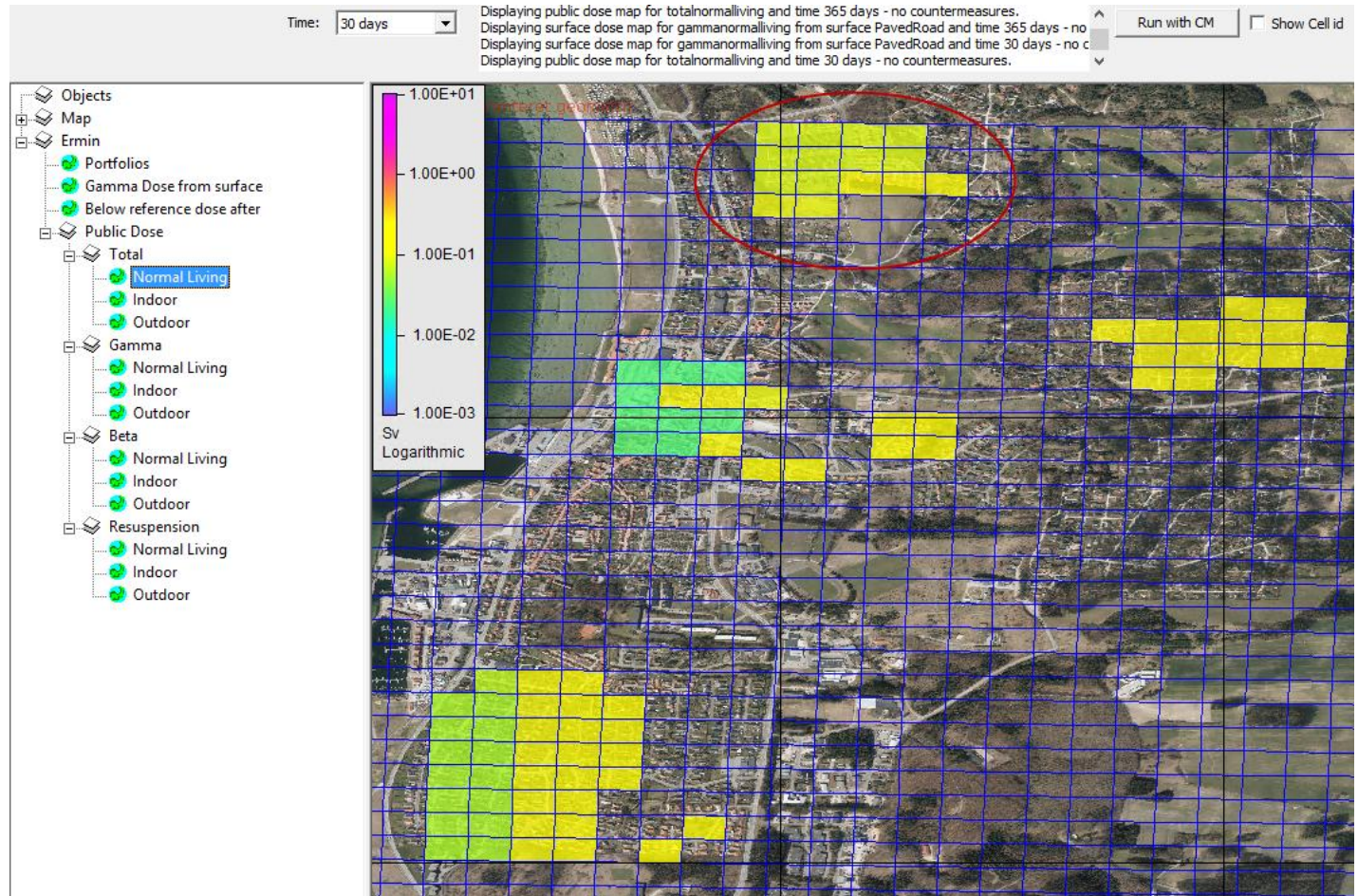
# Urban dose calculation

100 m grid

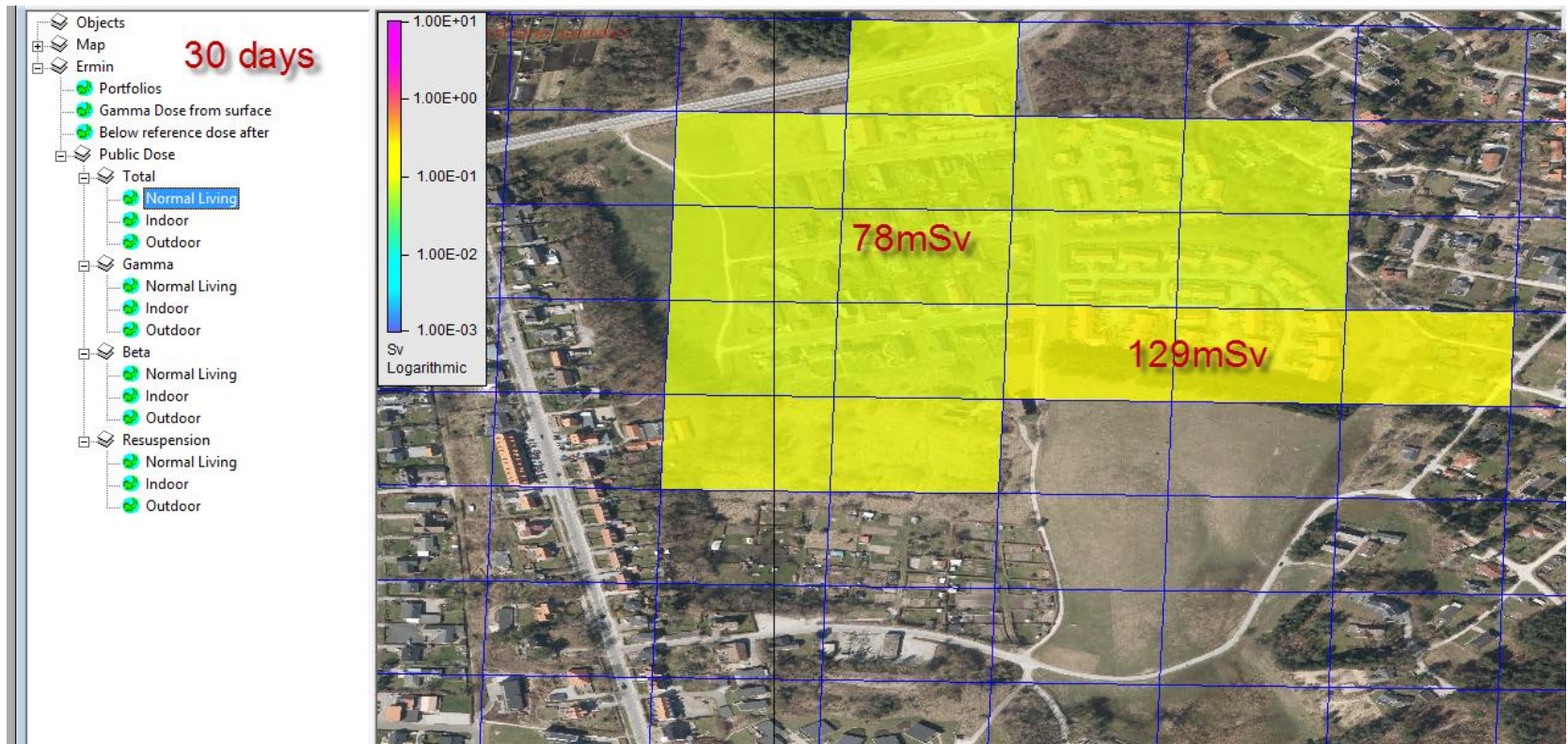




# Urban dose calculation

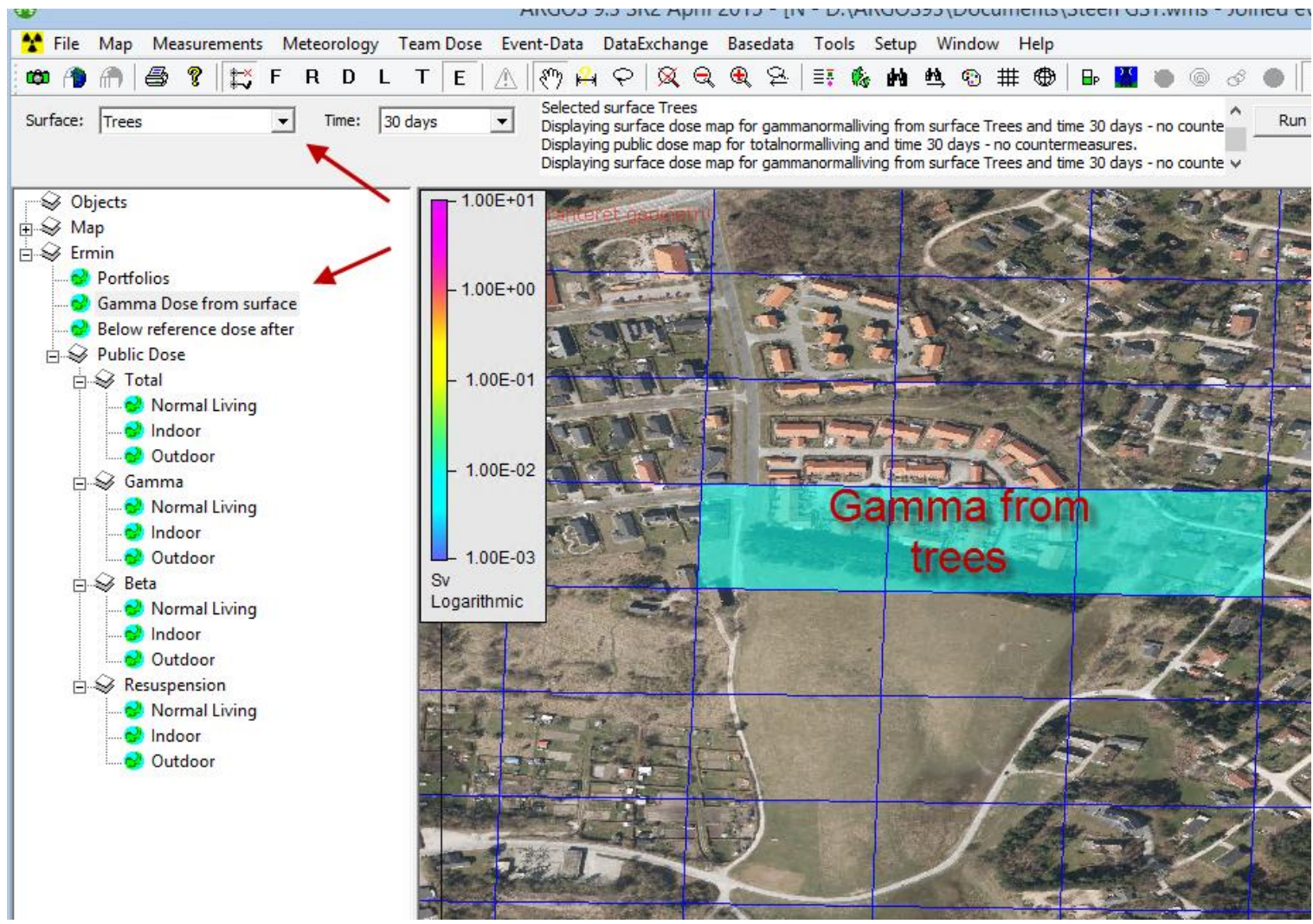


# Urban dose calculation





# Urban dose calculation



# Urban dose calculation

Countermeasure Strategies

Portfolio: 30 Days

Valid from 0 Sv to 1 Sv  
doses after 30 days

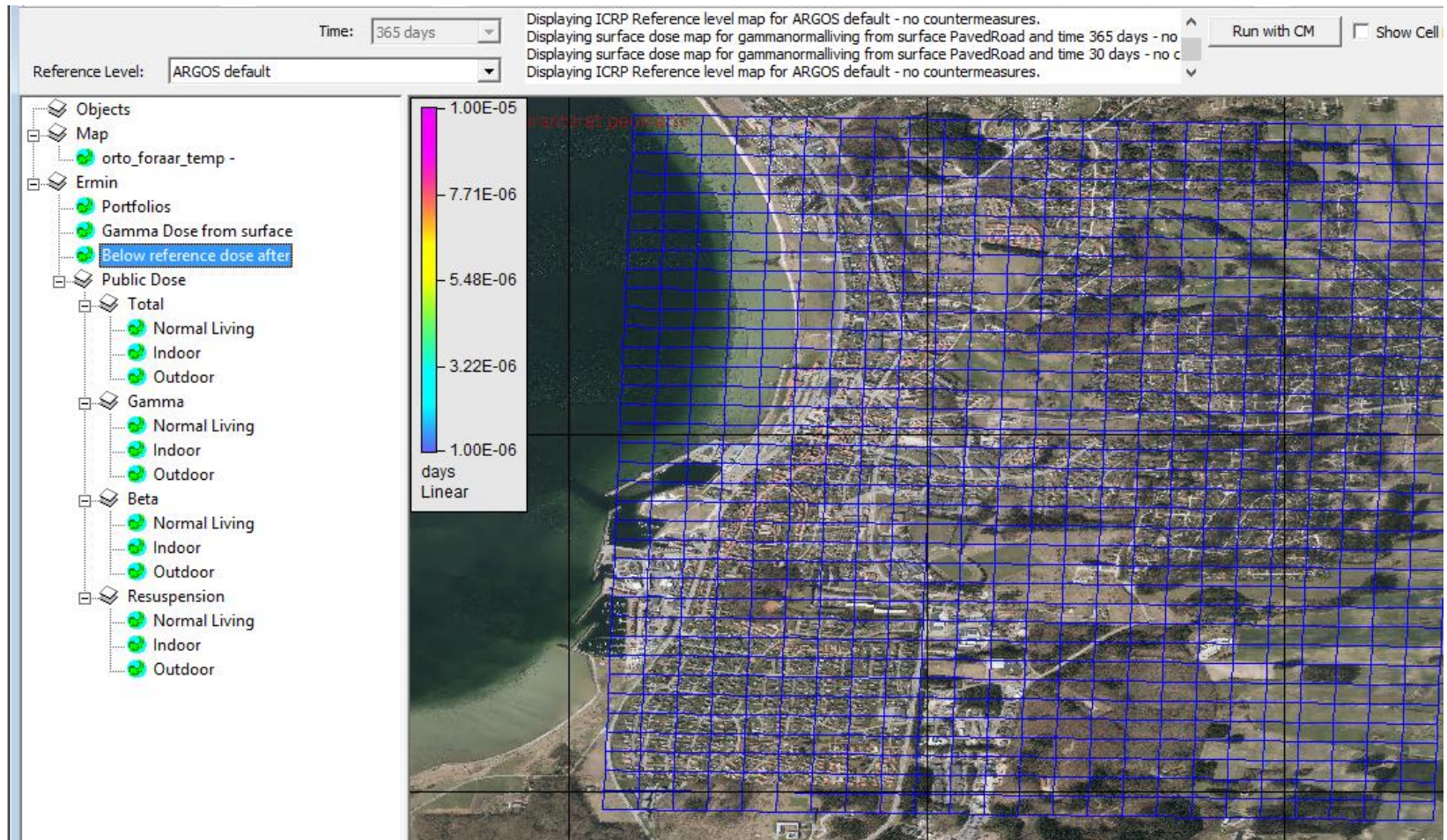
Grid Cells w/Dose, Saved dose and Worker dose [Sv]

Community	Grid ...	Expected	Collective	Saved: 1.Urban1	Saved: 2.Urban2	Worker: 1.Urban1	Worker: 2.Urban2	Waste [t]: 1.Urban1	Waste [t]: 2.Urban2
5km_6225_600	26	5.399E-02	7.019E-01	4.653E-02	2.745E-02	2.505E-03	1.179E-04	164.40	1
5km_6225_600	27	5.399E-02	9.719E-01	4.653E-02	2.745E-02	2.505E-03	1.632E-04	164.40	1
5km_6225_600	28	9.722E-02	2.333E+00	8.378E-02	4.942E-02	4.534E-03	3.921E-04	164.40	1
5km_6225_600	29	1.404E-01	1.826E+00	1.210E-01	7.138E-02	6.563E-03	3.069E-04	164.40	1
5km_6225_600	31	1.478E-01	2.809E+00	1.274E-01	7.523E-02	7.045E-03	4.925E-04	164.40	1
5km_6225_600	50	5.399E-02	1.782E+00	4.653E-02	2.745E-02	2.505E-03	2.992E-04	164.40	1
5km_6225_600	51	5.399E-02	7.559E-01	4.653E-02	2.745E-02	2.505E-03	1.269E-04	164.40	1
5km_6225_600	52	9.722E-02	1.167E+00	8.378E-02	4.942E-02	4.534E-03	2.049E-04	164.40	1
5km_6225_600	53	1.404E-01	3.230E+00	1.210E-01	7.138E-02	6.563E-03	5.429E-04	164.40	1
5km_6225_600	56	1.478E-01	3.253E+00	1.274E-01	7.523E-02	7.045E-03	5.702E-04	164.40	1
5km_6225_600	74	5.399E-02	1.512E+00	4.653E-02	2.745E-02	2.505E-03	2.539E-04	164.40	1
5km_6225_600	75	5.399E-02	9.179E-01	4.653E-02	2.745E-02	2.505E-03	1.541E-04	164.40	1
5km_6225_600	76	9.722E-02	2.625E+00	8.378E-02	4.942E-02	4.534E-03	4.411E-04	164.40	1
5km_6225_600	77	1.404E-01	3.652E+00	1.210E-01	7.138E-02	6.563E-03	6.137E-04	164.40	1
5km_6225_600	98	5.399E-02	1.080E+00	4.653E-02	2.745E-02	2.505E-03	1.813E-04	164.40	1
5km_6225_600	99	5.399E-02	1.188E+00	4.653E-02	2.745E-02	2.505E-03	1.995E-04	164.40	1
5km_6225_600	100	9.722E-02	6.805E-01	8.378E-02	4.942E-02	4.534E-03	2.049E-04	164.40	1
5km_6225_600	101	1.404E-01	1.545E+00	1.210E-01	7.138E-02	6.563E-03	2.965E-04	164.40	1
5km_6225_600	102	1.404E-01	3.511E+00	1.210E-01	7.138E-02	6.563E-03	5.901E-04	164.40	1
5km_6225_600	122	5.399E-02	9.719E-01	4.653E-02	2.745E-02	2.505E-03	1.632E-04	164.40	1
5km_6225_600	123	5.399E-02	9.179E-01	4.653E-02	2.745E-02	2.505E-03	1.541E-04	164.40	1
5km_6225_600	124	9.722E-02	1.361E+00	8.378E-02	4.942E-02	4.534E-03	2.287E-04	164.40	1
5km_6225_600	125	1.404E-01	3.090E+00	1.210E-01	7.138E-02	6.563E-03	5.193E-04	164.40	1

Remove Upgrade Downgrade



# Urban dose calculation



# Lessons identified – personal view

- More training of key player in the crises committee/problems with formats of results.
- Experts was separated under the exercise, creating communication problems.
- The crisis committee do not accept uncertainty they want yes or no?
- The crisis committee will take the most conservative approach when implementing countermeasures after a radioactive contamination?
- We have the tools, but can we explain why we should use them?



# The near future for the Nordic DSS

- Updated models with support for the new BSS's
  - ERMIN 2 and AgriCP is updated to include the new concepts from ICRP103/109.
  - ARGOS is a important tools for the implementation of the new BSS.
- Source Terms for NPP will come later in the new EU-research - FASTNET project.