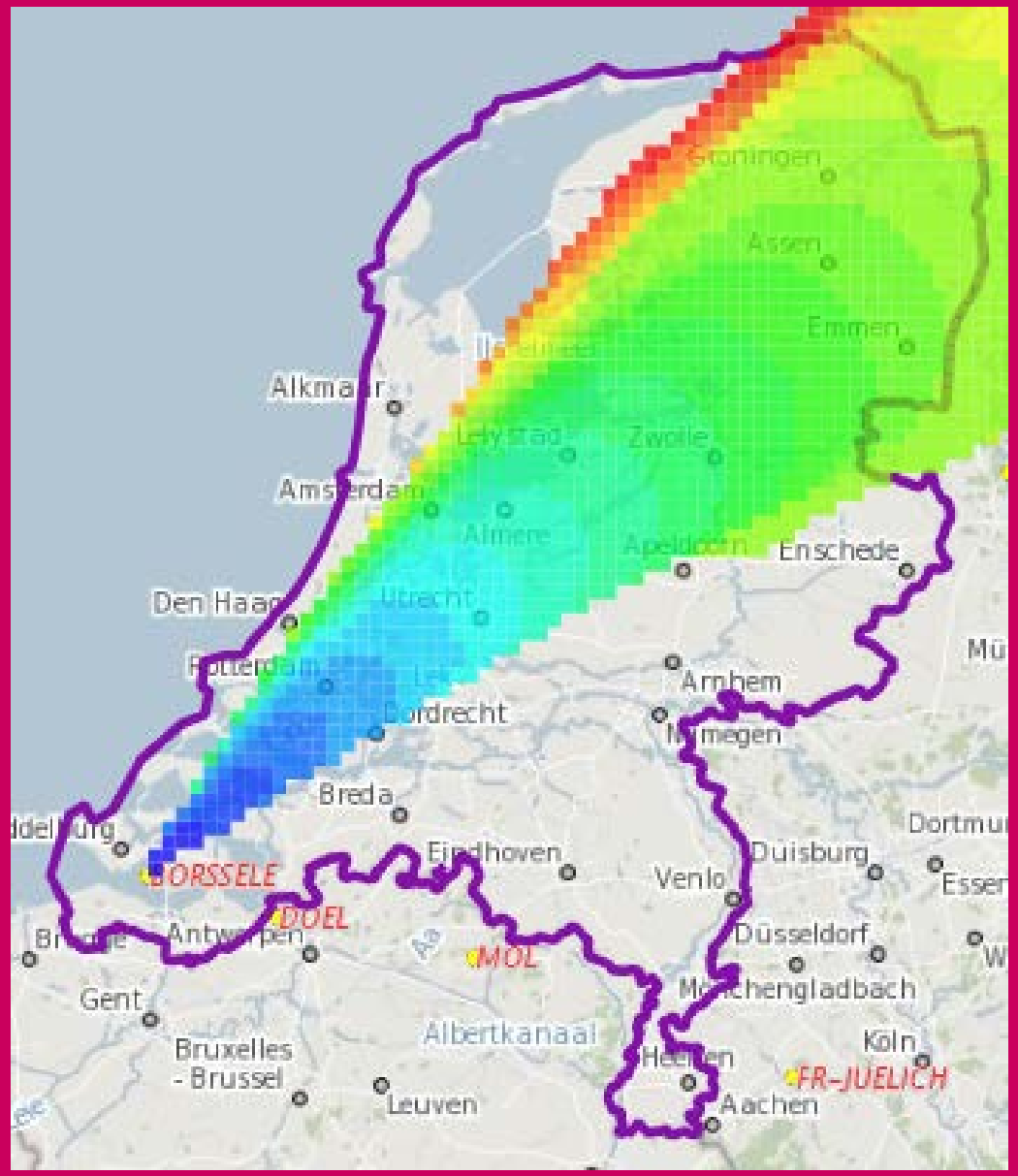

National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

A probabilistic approach for determining potentially affected areas for accidental releases

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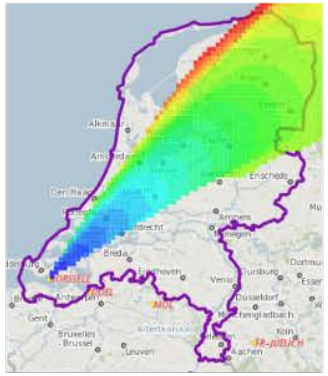
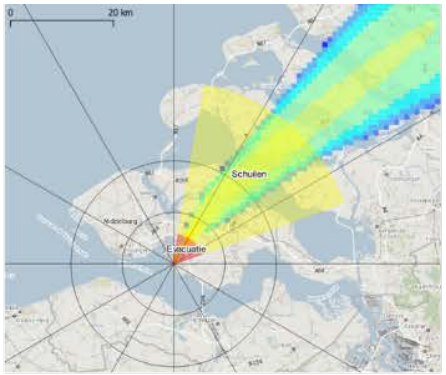
Nuclear accident

- Release of radioactive material into the air
  - Dispersion
- Radiation exposure → radiation dose → health effects
- Protective measures to avoid or reduce health effects
  - Evacuation, sheltering, iodine thyroid blocking
  - Dose criteria
  - Preparations is planning areas

➢ Estimation of the potential dose

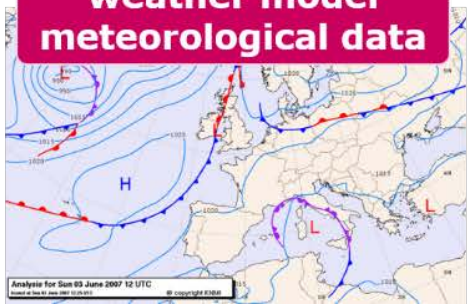
Model chain - emergency





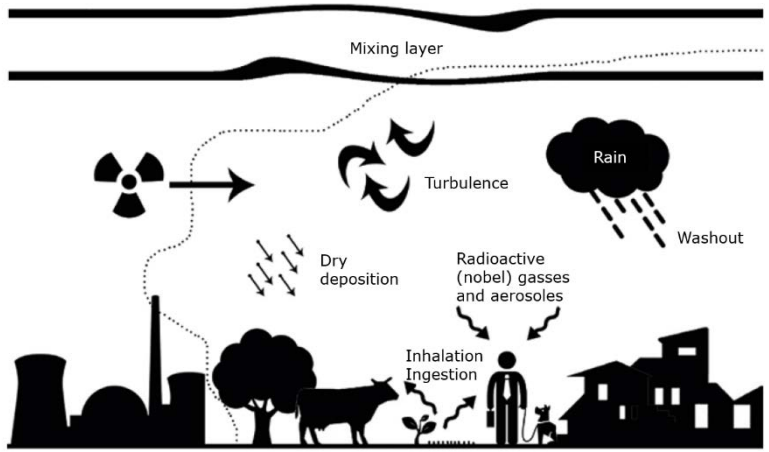
scenario incident → **source term** → **air dispersion modelling** → **doses** → **measures**

weather model meteorological data → **air dispersion modelling**



sheltering
evacuation
iodine thyroid blocking

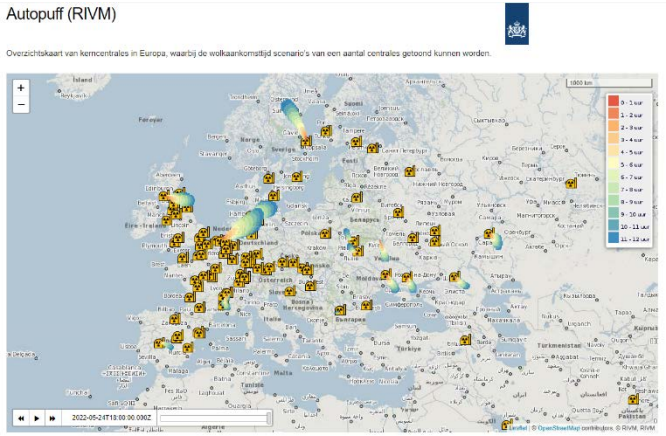
Dose calculation



air concentration | **deposition** | **dose**

Dose contributions:
- passing radioactive cloud (external radiation, inhalation)
- deposition (external radiation)

Other pathways are not considered – small contributions

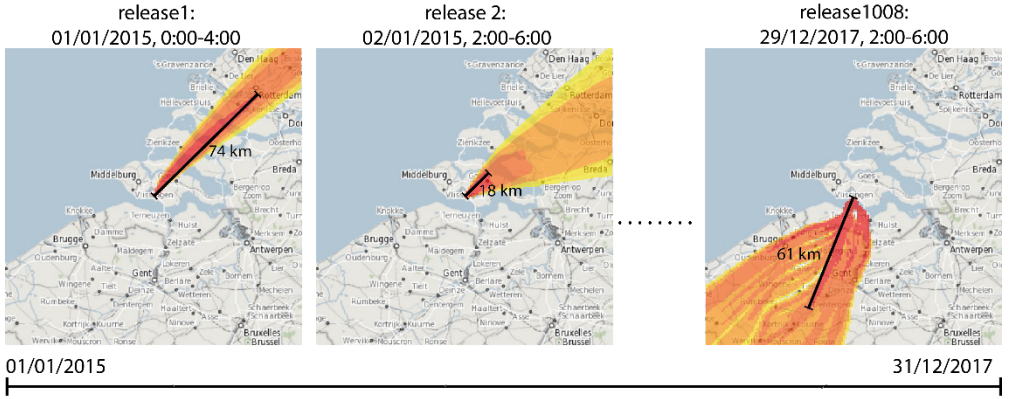


Preparation

- Planning areas based on wide range of meteorological conditions
  - Probabilistic modelling:
    - multiple releases of radioactive material
    - varying meteorological conditions
    - covering seasonal and day-to-night variations

- Geometrical characteristics of affected areas
- Effect release duration (4 & 96 hours) and height (25 & 60m)

Probabilistic model chain



every 26 hours, 3 years (2015-2017)

~ 1000 NPK-PUFF model runs (Gaussian puff)

nested grid (1x1, 2x2, 4x4 km; 150, 300, 600km)

large core meltdown (duration), smaller (height)

NWP HARMONIE

(2.5x2.5 km; 10, 50, 100, 200, 300m)

distances and areas

Results
release duration

4 hours

Table 1. Percentiles of maximum distance and surface area for exceeding dose criteria in scenario 1a.

Measure	Percentiles (km) distance					Percentiles (km²) surface area				
Dose criterion	**50%**	**75%**	**80%**	**90%**	**95%**	**50%**	**75%**	**80 %**	**90%**	**95%**
Evacuation (adults)	4	6	8	11	14	3	5	7	12	18
100 mSv effective dose										
Sheltering (adults)	16	24	30	42	55	29	56	89	207	592
10 mSv effective dose										
Iodine tablets (1-year-old)	38	57	71	95	119	161	310	456	707	1007
50 mSv thyroid dose										

3-4x

20x

96 hours

Table 2. Percentiles of maximum distance and surface area for exceeding dose criteria in scenario 1b.

Measure	Percentiles (km) distance					Percentiles (km²) surface area				
Dose criterion	**50%**	**75%**	**80%**	**90%**	**95%**	**50%**	**75%**	**80 %**	**90%**	**95%**
Evacuation (adults)	2	2	3	3	3	2	3	3	4	5
100 mSv effective dose										
Sheltering (adults)	11	14	16	18	21	43	56	65	80	97
10 mSv effective dose										
Iodine tablets (1-year-old)	30	37	41	47	55	282	380	449	551	693
50 mSv thyroid dose										

2x

2x

- Shorter release:
  - larger maximum distances and areas (green)
    - Spread due to varying meteorological conditions
  - relatively larger difference between 50 and 95 percentile (pink)
    - More variation in size and distance for planning

Results
release height

25 m

Table 3. Percentiles of maximum distance and surface area for exceeding dose criteria in scenario 2a.

Measure	Percentiles (km) distance					Percentiles (km^2) surface area				
Dose criterion	**50%**	**75%**	**80%**	**90%**	**95%**	**50%**	**75%**	**80 %**	**90%**	**95%**
Evacuation (adults)	-	-	1	2	3	-	-	1	1	1
100 mSv effective dose										
Sheltering (adults)	6	8	10	13	17	5	9	13	19	29
10 mSv effective dose										
Iodine tablets (1-year-old)	11	16	19	26	33	15	28	44	74	103
50 mSv thyroid dose										

60 m

Table 4. Percentiles of maximum distance and surface area for exceeding dose criteria in scenario 2b.

Measure	Percentiles (km) distance					Percentiles (km^2) surface area				
Dose criterion	**50%**	**75%**	**80%**	**90%**	**95%**	**50%**	**75%**	**80 %**	**90%**	**95%**
Evacuation (adults)	-	-	-	-	-	-	-	-	-	-
100 mSv effective dose										
Sheltering (adults)	5	7	9	12	15	4	5	7	12	16
10 mSv effective dose										
Iodine tablets (1-year-old)	11	16	19	26	33	14	24	37	67	91
50 mSv thyroid dose										

- Higher release has slightly lower maximum distances and lower areas
  - Less pronounced for thyroid doses

Conclusion

- Methodology for identifying characteristics of planning zones for nuclear accidents
- Results for two specific scenarios
- Insight into indicators for deriving planning zones
- Methodology can be applied to wide range of cases where current meteorological conditions are for example unknown or rapidly changing

Thank you for your attention

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