Overview of legacy/NORM sites in Belgium

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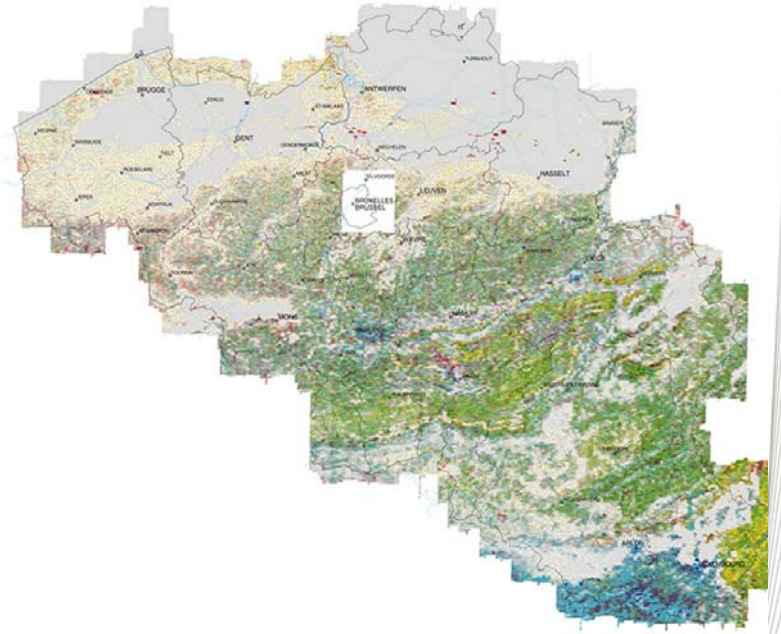
Introduction

In the 90s, **aerial gamma spectrometry** survey of Belgium (Geological Service of Belgium)



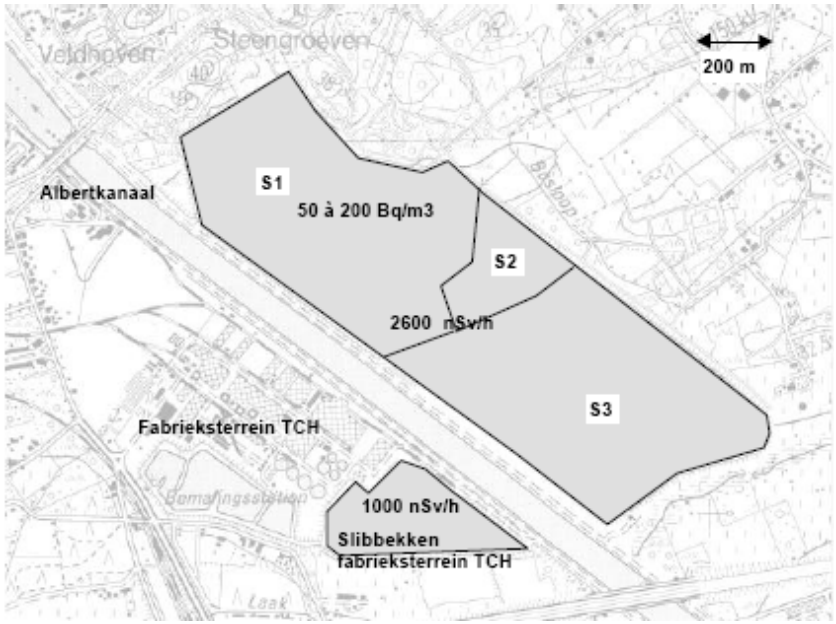
⇒ Identification of sites with elevated levels of radioactivity
⇒ majority of sites related to **phosphate** industry
⇒ radium extraction, FeNb,coal industry

Phosphate industry: the Tessenderlo's sites

Tessenderlo: treatment of phosphate ores to produce cattle food

HCl process => CaF_2 sludges as residues

⇒ Disposal on landfills ("Veldhoven")



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Phosphate industry: the Tessenderlo's sites (2)

	Area (ha)	Volume (tons)	Years of exploitation
S1	25	900,000	1963-1986
S2	4	50,000	(buffer dump) ~1980- today
S3	26	900,000	1987 - today
Dumpsite on factory premises	5.6	150,000	1935 - ~1970

+ two others disused dumpsites 1-2km SW

Tessenderlo: radiological data

- Till 1995, **Ra-226** concentration in CaF_2 sludges

  ~ 3.5 Bq/g (but significant concentration of radium in waste water)
- Since 1995, changes in the process (co-precipitation of Ra with Ba): increase of Ra-226 concentration in sludges **~11 Bq/g**
- External dose rate on dumpsite: **up to 2.5 µSv/h**
- Radon monitoring since 1993: **up to ~ 500 Bq/m3**

Tessenderlo: site data

Surface waters + hydro-geology

- Canal + two small rivers ("Bosloop"+ "Grote Beek" (2000 m^3/h))
- Groundwater: flow towards "Grote Beek" (cross sectional area: 2600 m^2 – flowrate: 10 m/y)

Nature of soil: sandy

Tessenderlo: radiological assessment

EC Report (CARE):

"*Radiation Protection 115: Investigation of a possible basis for a common approach with regard to the restoration of areas affected by lasting radiation exposure as a result of past or old practice or work activity*" (H. Vandenhove et al.)

Two exposure scenarios:

i) **Normal evolution** (farmers residing and working close to the site) => dose of ~ 0.5mSv/y

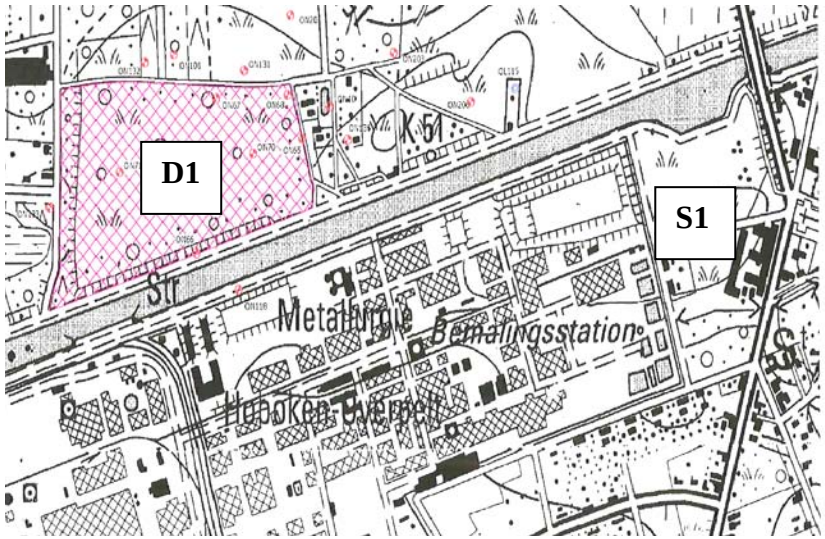
ii) **Intrusion scenario** (living in houses built on site) => 357 mSv/y (radon biggest contributor)

Olen site

Metallurgical company: radium extraction and production of radium sources from 1922 till 1969

⇒ Dumpsites D1 and S1 (to be remediated)

⇒ Contamination of banks of nearby river (« Bankloop ») (remediation project almost over => licensed disposal site for remediation waste)



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Olen site

Dump	Area (ha)	Volume (m^3)
D1	10	217,000
S1	2.4	207,000

D1 dump: iron hydroxide and $CaSO_4$ (non-ferrous activities) + residues from radium extraction + rubbles from dismantlement radium facility

S1 dump: residues from cobalt production + radium contaminated dredging sludges

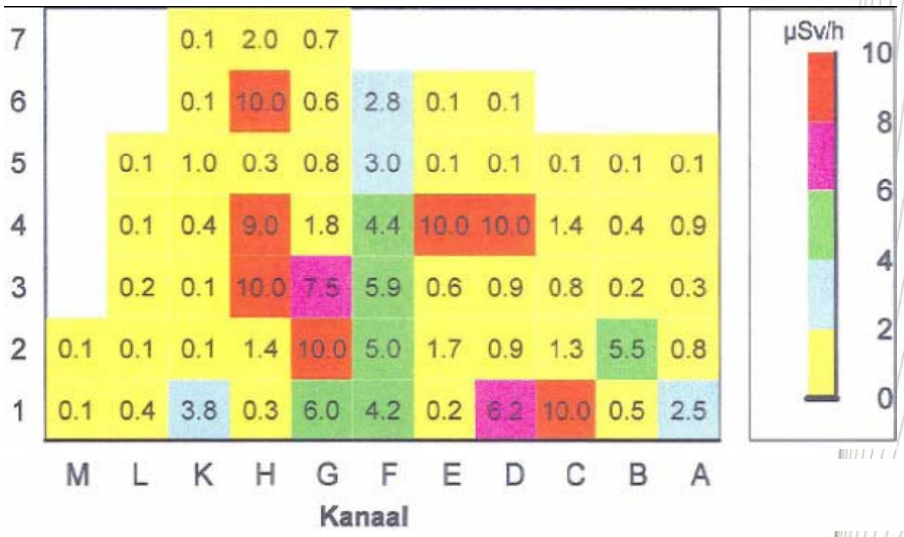
Olen site: radiological data

D1 dump

- Highly inhomogeneous Ra-226 concentration: 40 Bq/kg up to 930Bq/g (average ~20 Bq/g)
- U-238 ~ 200 Bq/kg
- Th-230 ~ Ra-226

Rn-222 up to ~1300 Bq/m^3

Dose rate D1



S1 dump

- Band of contaminated material 6-8m depth
- Ra-226 ~ 10 Bq/g
- U-238 up to 2 Bq/g
- Th-230 up to 2.6 Bq/g

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Olen: site data

Groundwater:

- 1 – 2 m beneath ground level
- Direction of flow: towards “Kleine Nete” river

(~ 850 m North of D1 dump – flowrate ~ 9000 m^3/h)

Nature of soil: sandy

Specific data about climate and diet of population available

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Olen: radiological assessment

Study in the framework of IAEA **BIOMASS** program (focused on contamination **outside** dumpsites):

"*Testing of environmental transfer models using data from the remediation of a radium extraction site*" (L. Sweeck et al.)

D1 dump: assessment by SCK-CEN (Belgian Nuclear Study Centre)

- Normal evolution: ~ 2 mSv/y
- Intrusion: ~ 56 mSv/y

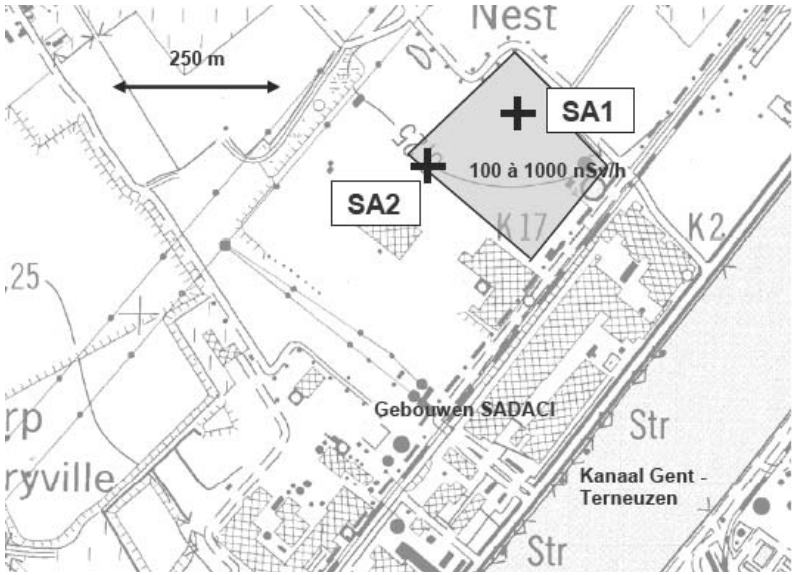
Other sites

(NB: source of information **SCK-CEN** study)

<u>Ghent</u>: former dumpsite (slags) of **ferro-niobium** extraction facility

⇒ (patchy) contamination up to 60 Bq/g Th-232, 12 Bq/g U-238

⇒ radiological characterization to be carried out in 2010



Other sites (2)

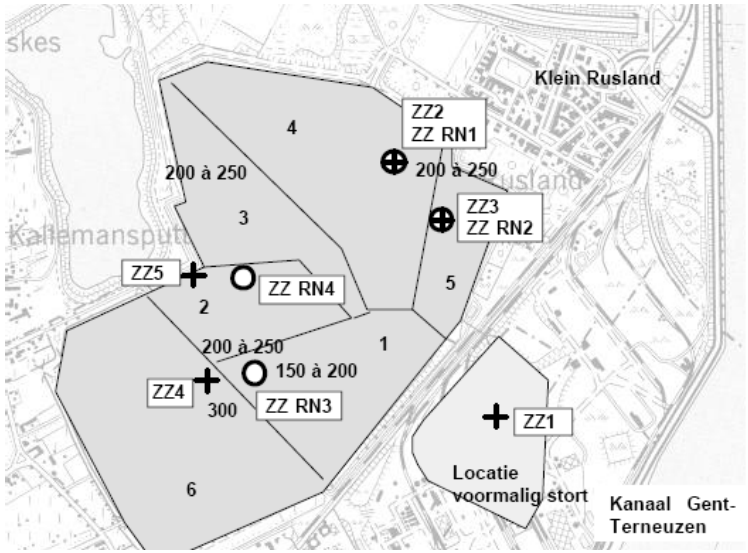
Ghent: PG stack (NB: ~ 10km to the North of FeNb site)

⇒ Ra-226 between 0.1 and 0.4 Bq/g

⇒ Th-232 between 0.05 and 0.4 Bq/g

⇒ Rn-222 + Rn-220 up to 130 Bq/m^3

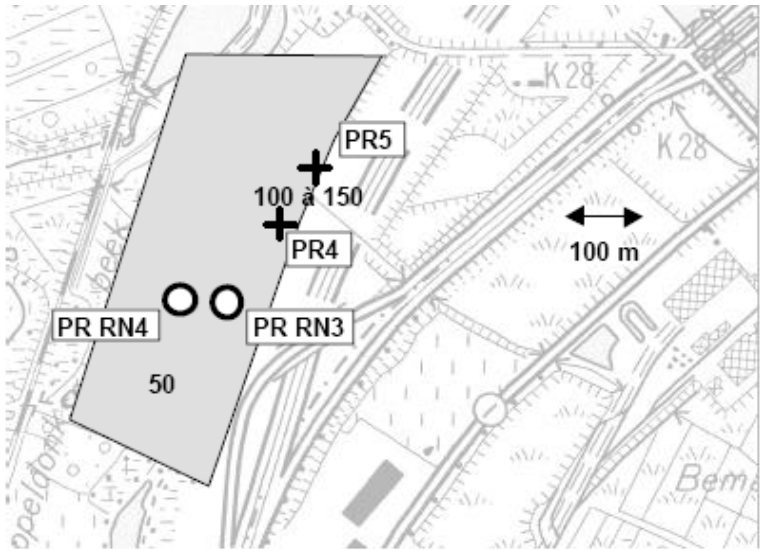
Operator was recently bankrupt => remediation to be foreseen



Other sites (3)

Puurs-Willebroek: 5 PG stacks close to each other

-Total quantity ~ 10 millions tons
- Ra-226 concentration up to 0.9 Bq/g
- Rn-222 up to 50 Bq/m^3



Other sites (4)

Oostende: 2 PG stacks (~ 3 km between each other) ~ 5km from the coast

- Ra-226 concentration up to 1 Bq/g
- Rn-222 up to 40 Bq/m^3

Data about geology and hydro-geology are available (remediation planned)