Groundwater remediation - Feedback after five years implementation of a decree on soil protection in Wallonia -

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How can a region with such a heavy and long industrial history only encounter such rare cases of heavy groundwater pollution?

How to make soil remediation procedure useful for groundwater bodies management/ characterisation?

How to convert administrative and technical data about polluted sites into a little number of georeferenced values

I. Data acquisition

- Date of data extraction for EU reporting (and for GQ19 publication : 16/05/2019
- Start of data encoding : 01/01/2014
- To go fast and to be efficient : working with the existing groundwater database ("old", not really adapted, but directly available)
- Each time an opinion is given on a new polluted site :
  - ⇒ Add some quali/piezometers including information about type, intensity and extension of pollution
  - ⇒ Link to it : analytical result tables, lithological and technical cross-sections, local pollution maps, ...
  - ⇒ Create a new georeferenced element (point located at the centre of the polluted zone) using an existing model :
    - Use the first "64k-line" of the field "description" of the form to store hydrogeological data (existence, sample, pollution state and risk level)
    - Use the second "64k-line" to store information about the state of progress along the administrative procedure : from characterisation study to final state reporting after remediation works ;
  - ⇒ Link quali/piezometers with their associated pollution
- Each time a new opinion is given on a already known polluted site (at further steps of the remediation procedure):
  - ⇒ Update "description" lines
  - ⇒ Add any useful technical data or results

Link

Visualisation d'un ouvrage

Date de création : 02/08/2019 — Date de mise à jour : 02/08/2019
Code de l'ouvrage : 40/5/3/011 — Identifiant interne : 88581
Eau souterraine : OUI — Zone vulnérable : NON
Commune nouvelle : MONT-SAINT-GUIBERT
Code INS : 25068
Commune ancienne : MONT-SAINT-GUIBERT
Code INS : 25068
Adresse (Rue,N°) : RUE DES TILLEULS 51
Code postal : 1435
Localité postale : MONT-SAINT-GUIBERT
Dénomination usuelle ou lieu dit : CUBIX IMMO PZ 4
Parcelle cadastrale : MONT-SAINT-GUIBERT/D3/SB/0025/00/H/000
Coordonnées X : 167582 M. Y : 146174 M.
Z (Niveau du repère de la mesure): M.
Z (Niveau topographique de l'ouvrage): 111 M.
Longitude Est : 4 36' 57"
Coordonnées exactes : GPS portable
Nom de l'exploitant : CUBIX IMMO
Adresse (Rue,N°) : RUE DES VÉTÉRINAIRES, 42
Code postal : 1070
Localité postale : BRUXELLES 7
Téléphone : 0479/94.66.51 GSM :
Nom de la personne à contacter : VINCENT LEBRUN
Qualité : EXPERT DESO
Téléphone : 081/335738 GSM :
Nature de l'ouvrage : PF — Date de réalisation : 20/03/2017
Date approximative :
Code batterie :
Profondeur de l'ouvrage : 3 M.
Profondeur de la crépine de : 1 M. à 3 M.
Analyse effectuée : OUI — Pompage d'essai : NON
Prise d'eau : NON — Piézomètre et/ou Qualitomètre : OUI
Code nappe : 210 — Code hydrographique ORI :
Type nappe : Libre
Sous-bassin hydrographique : DYLE-GETTE — Masse d'eau : SABLES DU BRUXELLIENS
Lien avec l'ouvrage :
Lien avec l'établissement classé : 40/5/3/002
Remarque : MIX DIESEL-GAZOLINE POLLUTION(SOIL AND GROUNDWATER) - SHALLOW - WEAK RISK BUT REMEDIATION PLANNED. SEE ANALYSES TABLE AND POLLUTION OUTLINES IN "IMAGES"

Date de création : 02/08/2019
Code de l'établissement polluant : 40/5/3/002
Commune nouvelle : MONT-SAINT-GUIBERT
Code INS : 25068
Commune ancienne : MONT-SAINT-GUIBERT
Code INS : 25068
Adresse (Rue,N°) : RUE DES TILLEULS 51
Code postal : 1435
Localité postale : MONT-SAINT-GUIBERT
Lieu dit ou nom : CUBIX
Coordonnées X : 167625 M. Y : 146198 M. Z : 111 M.
Coordonnées exactes : Approximatives
Nature de l'établissement : AVP
Description : I1100000
DES I100001
Nom de l'exploitant : CUBIX IMMO
Adresse (Rue,N°) : RUE DES VÉTÉRINAIRES, 42
Code postal :
Localité postale :
Téléphone : 0479/94.66.51
No de référence du dosssier : 2316/1/ECO1
No de l'autorisation :
Date de l'autorisation :

First line

	Is there any exploitable groundwater under the site?			Did the authors of the study perform any chemical analyses on this deep grounwater ?			Did the past/present industrial activities cause any pollution to this deep (exploitable) aquifer ?			Does this deep pollution generate any threat or risk in relation with groudwater ?			Is there any unexploitable shallow grounwater under the site?			Did the authors of the study perform any chemical analyses on this shallow grounwater ?			Did the past/present industrial activities cause any pollution to this shallow aquifer ?			Does this shallow pollution generate any threat or risk in relation with groudwater ?		
Value	0	1	2	0	1		0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2
Response	no	yes	HZ	no	yes		no	yes	?	no	yes	?	no	yes	GM	no	yes		no	yes	?	no	yes	?

H2: Houiller aquifer = deep but unexploitable — GM: Gravel of Meuse = Shallow but exploitable

second line

	Trigram - administrative procedure	Is an orientation study available ?		Is a caracterisation study available ?		Is a remediation project available?		Are remediation works already finished ?		Is monitoring underway?		Has a final inventory of fixtures been prepared?		Is there any residual pollution on the site?	
Value		0	1	0	1	0	1	0	1	0	1	0	1	0	1
Response		no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes

II. Data processing

General data processing

- Keep in mind the number of Potentially Polluted Site (PPP) computed in 2008 from 4 different public databases
- Count Sites for which at least one DESo Notice have been given to the administration of the soil Decree (S-DESoN)
- Add sites submitted to a notice within other framework (older remediation procedures, permitting procedures, waste management,...)
- Count how many sites :
  - ⇒ Are or have been affected by a groundwater pollution :
    - In a (shallow) permeable layer making a perched aquifer
    - In the (deep) permeable layer constituting the groundwater bodies
    - Which is likely to generate a risk to disperse and reach any local target (river, source, pumping well,...)
  - ⇒ have been remediated (soil and/or groundwater) : Number of Completed Soil Remediation Works ("CSRW")
  - ⇒ Are or have been monitored : Number of current and pas Monitorings ("Mon")

Data processing dedicated to GW-bodies characterisation

- "Clip" polluted sites into GW-bodies contour map
- Compute statistics specific to each of them : number (Nb), spatial density (SD,...)
  - ⇒ obtain better indicators of the pressure exerted by industrial activities ongroundwater quality :
    - Spatial density of Effective Groundwater Pollutions ("EGP")
    - Spatial density of Effective Shallow Aquifer Pollutions ("ESAP")
    - Spatial density of Effective Deep Aquifer Pollutions ("EDAP")
    - Spatial density of Effective Pollutions with possible Dispersion Risk ("EP-pDR") and, among them, the one where :
      - The risk is still present ("SP")
      - The risk is actively controlled ("AC") by barriers (pumping/reactive)
      - The risk is passively monitored ("PM") by a piezometer network
      - The risk is still To Be Assessed ("TBA")
      - The risk have been eliminated ("E") thanks to remediation works
    - **Global vulnerability ratio (nb of EAP/nb of PPS)** with EAP = **Exploited** aquifer pollution (shallow RWM071, RWM072 and RWM073, deep for other GW-Bodies)
    - **Intrinsic Vulnerability ratio (nb of P-DR/nb of** Pollutions)
    - Remediation rate (number of remediation works/number of EP-pDR) and monitoring rate (number of monitored sites/number of EP-pDR)
- Classify groundwater bodies as a function of these indicators in order to :
  - ⇒ Identify the most vulnerable bodies
  - ⇒ Better understand the relationships between number/density of potentially impacting sites, pollution nature/gravity and intrinsic hydrogeologic properties of each aquifer
  - ⇒ Prioritise actions (if needed) to better prevent and/or limit the pressure

zones	Area (km²)	PPP Nb	PPP SD	S-DESoN Nb	EGP Nb	EGP SD	EDAP Nb	EDAP SD	ESAP Nb	ESAP SD	EP-pDR Nb	EP-pDR SD	Nb of EP-PDR where the risk is SP	AC	PM	TBA	E	CSRW Nb	Mon Nb
Wallonia	16844	5152	31	859	642	3,8	175	1,0	513	3,0	142	0,8	0	16	56	8	63	369	545
Escaut District	3793	2011	53	343	285	7,5	92	2,4	219	5,8	75	2,0	0	5	32	2	36	142	228
RWE013	870	473	54	62	42	4,8	14	2	38	4,4	15	1,7	0	1	11	0	3	21	43
RWE030	477	493	103	51	43	9,0	24	5	20	4,2	19	4,0	0	1	10	1	7	21	41
RWE032	73	41	57	7	6	8,3	1	1	5	6,9	1	1,4	0	0	1	0	0	4	4
RWE033	167	304	182	41	33	19,8	9	5	27	16,2	9	5,4	0	0	1	1	7	21	26
RWE034	75	15	20	7	7	9	1	1	6	8,0	1	1	0	0	0	0	1	4	4
RWE051	965	292	30	88	76	7,9	32	3	51	5,3	17	1,8	0	3	6	0	8	31	48
RWE053	206	31	15	6	4	1,9	3	1	2	1,0	2	1,0	0	0	0	0	2	3	4
RWE061	389	204	52	46	42	10,8	3	1	42	10,8	3	0,77	0	0	1	0	2	19	32
RWE160	484	159	33	21	19	3,9	4	0,8	16	3,3	4	0,83	0	0	2	0	2	10	15

Classify

Groundwater bodies of Escaut district classified by

Density of PPS (Potentially Polluted Sites)		Density of DAP (Deep Aquifer Pollutions)		Density of P-DR (Pollutions with Dispersion Risk)		nb of EAP/nb of PPS (Global Vulérability ratio)		nb of P-DR/nb of P (Intinsic Vulnérability ratio)	
RWE033	182	RWE033	5,39	RWE033	5,39	RWE051	11%	RWE053	50%
RWE030	103	RWE030	5,03	RWE030	3,98	RWE053	10%	RWE030	44%
RWE032	57	RWE051	3,32	RWE051	1,76	RWE034	7%	RWE013	36%
RWE013	54	RWE013	1,61	RWE013	1,72	RWE030	5%	RWE033	27%
RWE061	52	RWE053	1,46	RWE032	1,38	RWE013	3%	RWE051	22%
RWE160	33	RWE032	1,38	RWE034	1,33	RWE033	3%	RWE160	21%
RWE051	30	RWE034	1,33	RWE053	0,97	RWE160	3%	RWE032	17%
RWE034	20	RWE160	0,83	RWE160	0,83	RWE032	2%	RWE034	14%
RWE053	15	RWE061	0,77	RWE061	0,77	RWE061	1%	RWE061	7%

What kind of indicator could allow to assess industrial pressure (punctual/diffuse) to the quality of groundwater bodies ?

How to pass from "potentially polluted sites" (potential pressure) to effective pollution (effective pressure) ?

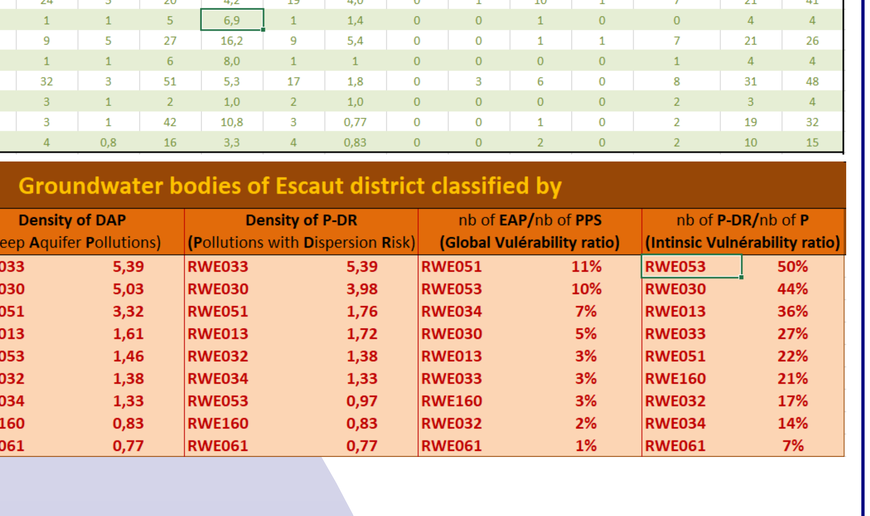
V. Update data

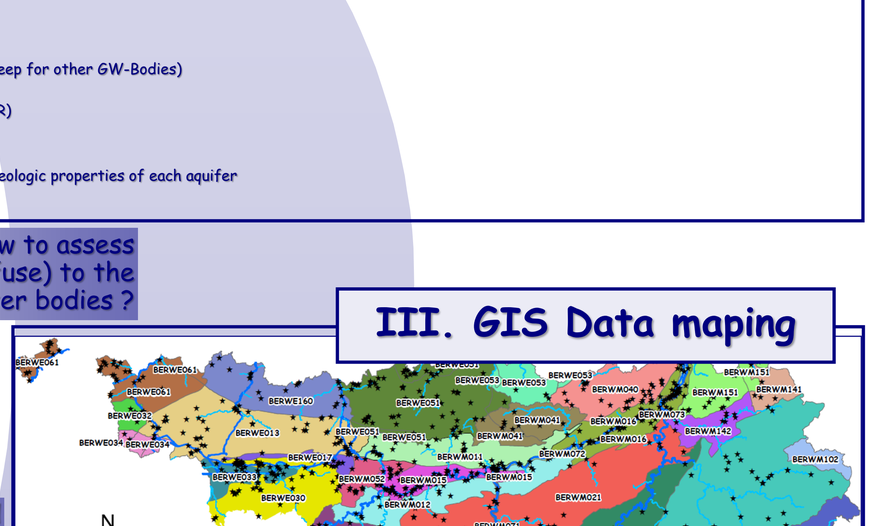
Do punctual pollutions of industrial origin have an effect on groundwater quality at a larger scale ?

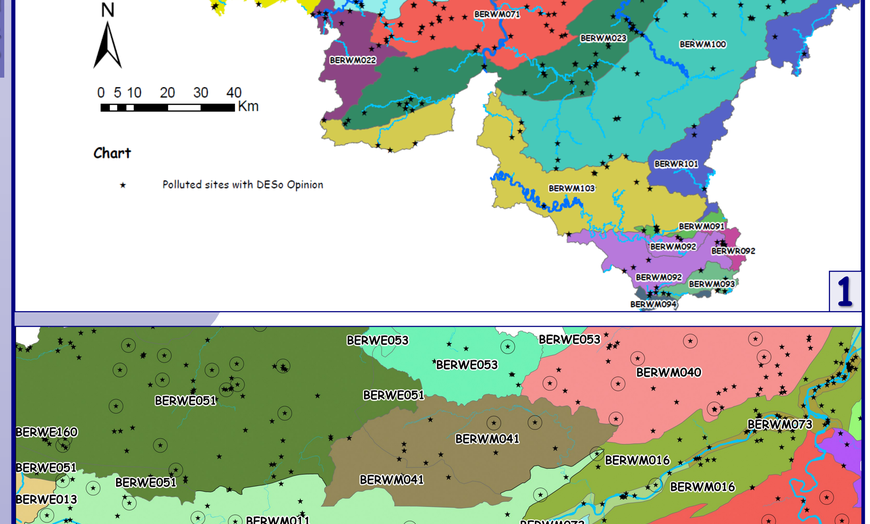
What do polluted sites statistics related to a given groundwater body tell us about its vulnerability to industrial pollutions?

How to combine large-scale monitoring of groundwater bodies based on a grid of low-density observation points with small-scale monitoring of local groundwater pollutions using a dense network of piezometers?

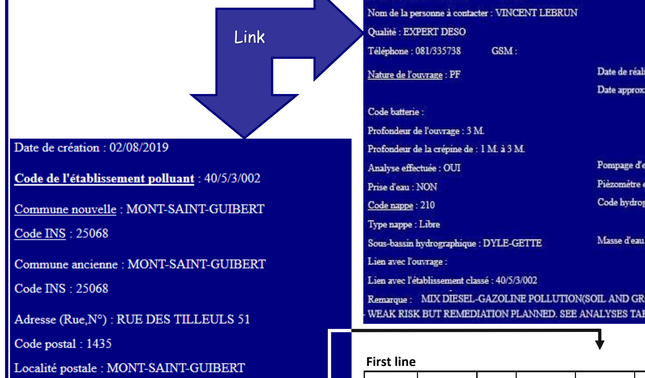
III. GIS Data maping

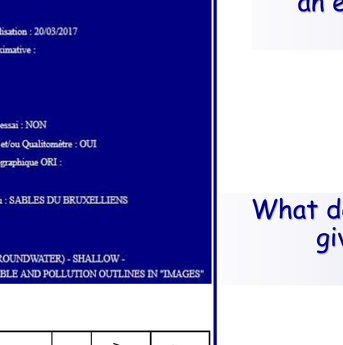


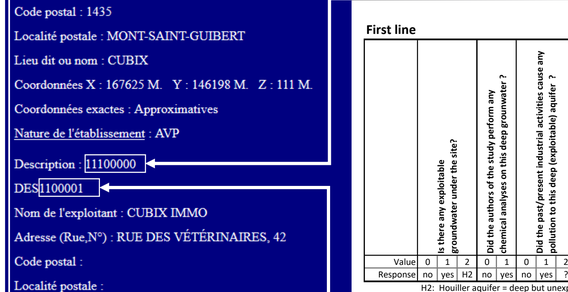




IV. Data interpretation and reporting







Meuse GW Bodies in decreasing order of D of PPS		D of DAP		D of P-DR		Meuse GW Bodies in decreasing order of Global vulnerability ratio		Intrinsic vulnérability ratio	
RWM073	866	RWM073	102.0	RWM073	15.19	RWM072	17%	RWM040	58%
RWM072	205	RWM072	34.4	RWM071	5.24	RWM071	12%	RWM012	33%
RWM071	189	RWM071	23.6	RWM040	2.56	RWM073	12%	RWM091	33%
RWM142	150	RWM052	7.8	RWM072	2.55	RWM041	11%	RWM141	33%
RWM052	97	RWM040	3.0	RWM091	1.56	RWM040	9%	RWM092	31%
RWM141	46	RWM141	1.5	RWM052	1.41	RWM052	8%	RWM100	26%
RWM151	44	RWM011	1.4	RWM011	1.20	RWM092	8%	RWM011	24%
RWM012	41	RWM151	1.4	RWM092	0.95	RWM011	4%	RWM071	22%
RWM040	35	RWM041	1.3	RWM012	0.87	RWM141	3%	RWM151	20%
RWM011	33	RWM012	1.1	RWM141	0.74	RWM151	3%	RWM021	18%
RWM022	25	RWM092	0.8	RWM151	0.70	RWM021	3%	RWM073	15%
RWM093	24	RWM021	0.4	RWM041	0.3	RWM012	3%	RWM041	13%
RWM023	23	RWM023	0.3	RWM100	0.21	RWM100	2%	RWM052	11%
RWM021	15	RWM022	0.2	RWM021	0.18	RWM023	1%	RWM023	10%
RWM103	15	RWM100	0.2	RWM023	0.13	RWM022	1%	RWM103	10%
RWM091	14	RWM103	0.1	RWM103	0.07	RWM103	0%	RWM072	
RWM041	12	RWM091	0.0	RWM022	0.00	RWM091	0%	RWM022	
RWM092	10	RWM093	0.0	RWM093	0.00	RWM093	0%	RWM093	

4

General overview and global point of view

- Among 3000 sites have been studied within the framework of 2008-2018 soil decrees
- Only a third of soil investigation reports are submitted to DESo for opinion (1000 advices concerning 850 polluted sites), among which only 20% concerns "deep aquifer pollutions"
- 16 % of these opinions have been concluding to the potential existence of a dispersion risk at a time of the procedure
  - ⇒ Only 5 % of potentially polluted sites significantly impact groundwater quality
    - The risk is most often limited to local scale lateral dispersion in shallow aquifers -> groundwater remediation techniques (including hydrogeological barriers) often allow to eliminate or reduce it down to an acceptable level within a short period of time
      - ⇒ It remains no site with current risk
    - Abundance of monitored polluted sites allows to obtain quali/quantitative observation points completing the current network (Fig. 2)

Are local soil and groundwater remediation works sufficient to ensure a long-term integrity of groundwater bodies?

Is it worth investing so much effort to avoid small-scale "one-off" problems?

Should we not reorient some of these heavy investments to fight against larger-scale diffuse pollutions (agricultural sector)?

Findings related to Groundwater bodies

- Pollutions located along main valleys (**Fig. 2 & 3**) -> alluvial aquifers act as vertical biochemical barriers between pollution and GW-bodies
- Many polluted sites installed historically along the coal deposit (**Fig. 3**), which does not contain good quality groundwater -> "no target"
- Some GW-bodies (**Fig. 4**), like RWM073, show high concentration of polluted site but proportionally lower density of risk-generating pollutions <-> their intrinsic vulnerability is low (have-captivity under clay layer, high natural attenuation index, low gradient, ...)
- Inversely (**Fig. 4**) , other GW-bodies, like RWM040, show low density of PPS but proportionally higher density of risk-generating pollutions <-> their intrinsic vulnerability is high (low dilution rate, low natural attenuation index, high gradient, high permeability, ...)
- Be careful (**Fig. 4**) that some GW-Bodies, like RWM092, present very few PPS and/or pollution with DESo opinion -> only 1 or 2 "deep aquifer pollutions" or "risk-generating pollutions" make vulnerability rates to grow a lot <-> rates are not statistically representative
- 2 GW-Bodies are suspected to be regionally impacted by old industrial activities (diffuse pollution resulting from the addition of punctual pollutions). RWE030 is probably enriched in SO_4 and N by the leaching of a huge quantity of mining waste stored in heaps directly above the chalk aquifer formation (**Fig. 4**)
- Sites close to the limit of GW-Bodies may be used to refine the contours of the body by adding local geodata (**Fig. 5**)

Conclusion and scopes

- From the groundwater point of view, soil-remediation Decree procedure allows to threat pollutions "from the source", mainly before it creates a risk
- Up to now, it has been solving or preventing any regional degradation of a groundwater body
- It gives to GW-administration the way to obtain better estimator of industrial pressure of each groundwater body and to prioritise remediation or monitoring actions (**Fig. 4, 7 and 8**)
- It provides new observation points to quanti/qualitative regional survey (**Fig. 2**)
- Groundwater remediation work goes further than necessary risk-elimination or risk management tasks, for many administrative reasons : a part of the total financial amounts invested in soil remediation could be used to solve other problems related to groundwater bodies :
  - ⇒ Fight against diffuse agricultural pollutions
  - ⇒ Prevent overexploitation

Potential pressure indicators

	negligible	low	medium	high	very high
Density of current classified industrial activities	<5	5-20	20-50	50-100	>100
Density of current classified tertiary and agricultural activities					
Density of potentially polluted sites (current and/or past)					

Effective pressure indicators and risk indicators

	negligible	low	medium	high	very high
Global vulnerability index	0%	0-3%	3-5%	5-10%	>10%
Intrinsic vulnerability index	0%	0-15%	15-30%	30-50%	>50%
Effective pressure before remediation works (deep aquifer pollutions/100 km²)	0	0-0.5	0.5-1	1-5	>5
Effective pressure after remediation works	0				

Groundwater remediation and monitoring actions indicators

	deficitary	acceptable	good	very good	excellent
Grounwater remediation index (nb grounwater remediation work/nb pollution with risk	<100%	100%-110%	110%-150%	150%-250%	>2
Groundwater monitoring index					

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Density of industrial polluting activities	5 < **10** < 20	Low
Density of other classified activities (agricultural + tertiary)	5 < **10** < 20	Low
Density of PPS	5 < **10** < 20	Low
Potential industrial pressure	High	
Global vulnerability ratio	5% < **8%** < 10%	High
Intrinsic vulnerability ratio	30% < **31%** < 50%	High
Current pressure after remediation works	0.5 < **0.95** < 1	Medium
Remediation ratio	150% < **180%** < 250%	Very good
Monitoring ratio	250% < **280%**	Excellent
Current pressure after remediation works	0 (no site with current risk)	Negligible
Effective industrial pressure	**medium**	
Diffuse industrial pressure	**Inexistent**	

8

Legal framework

European Commission (2000) :
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Official Journal of European Commission (O.J.E.C.), L 327 of 12.22.2000, 72 pp.

Région Wallonne (2008) :
Décret du Gouvernement wallon du 5 décembre 2008 relatif à la gestion des sols, Belgian Monitor, Published on : 2009-02-18

Région Wallonne (2018) :
Décret du Gouvernement wallon du 1er mars 2018 2008 relatif à la gestion et à l'assainissement des sols, Belgian Monitor, Published on : 2018-03-22