Delineating 'groundwater bodies' and optimisation of the groundwater monitoring network (in the scope of the EC Water Directive 2000/60/CE)

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Hydrogéologie

Outline

- delineating 'groundwater bodies'
  - theory … and practice
- optimisation of the groundwater monitoring network
  - theory … and practice
- test application of the SEQ-ESO as groundwater quality evaluation tool

…in the scope of the EC Water Directive 2000/60/CE)

Hydrogéologie

Delineating 'groundwater bodies': theory

Elements of Characterization

Hydrology
- annual precipitation

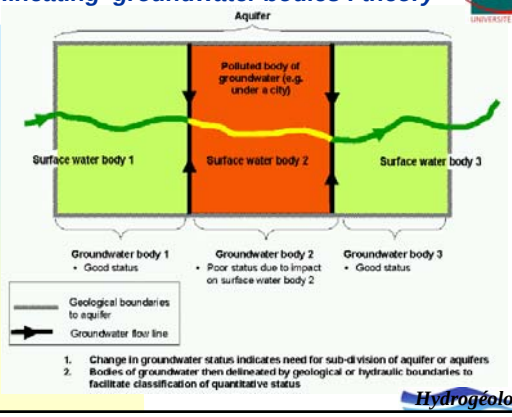
Geology
- stratigraphy
- lithology
- thickness
- overlying strata
- depth to groundwater

Hydrogeology
- recharge (precipitation, surface waters, groundwaters, springs, irrigation)
- hydraulic conductivity
- annual piezometric amplitudes

Pressures
- land use
- water abstractions
- artifical recharge
- main infrastructures
- associated aquatic ecosytems

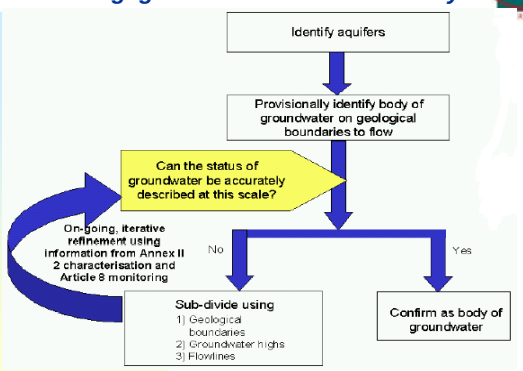
Hydrogéologie

Delineating 'groundwater bodies': theory



Hydrogéologie

Delineating 'groundwater bodies': theory



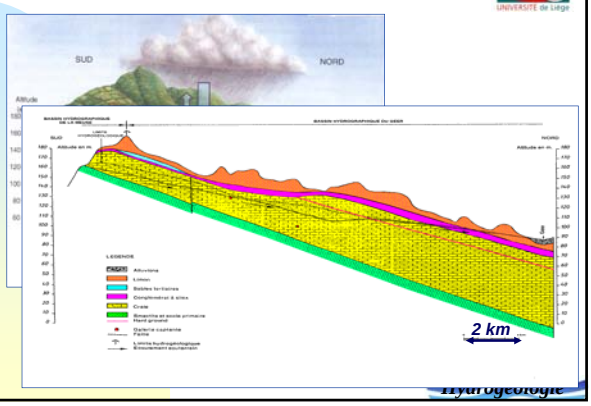
Hydrogéologie

Delineating 'groundwater bodies' aims: characterization & management

- initial characterisation requires collation of data on pressures on GW body(ies):
  - diffuse sources of pollution
  - point sources of pollution
  - abstraction
  - artificial recharge
  - general character of overlying strata in recharge areas and dependent ecosystems
- use only existing data at initial characterisation
- data on distribution of pressures, observed impacts

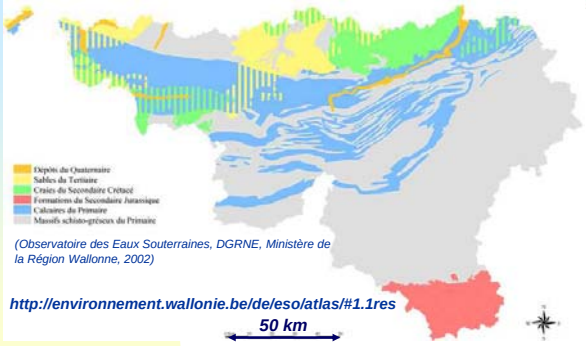
Hydrogéologie

Delineating 'groundwater bodies': practice



Hydrogéologie

Delineating 'groundwater bodies': practice



(Observatoire des Eaux Souterraines, DGRNE, Ministère de la Région Wallonne, 2002)

http://environnement.wallonie.be/de/eso/atlas/#1.1res

Hydrogéologie

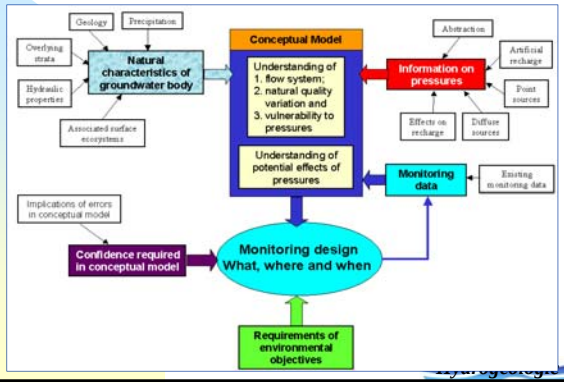
Delineating 'groundwater bodies': practice

management reasons:
- quantity
- quality

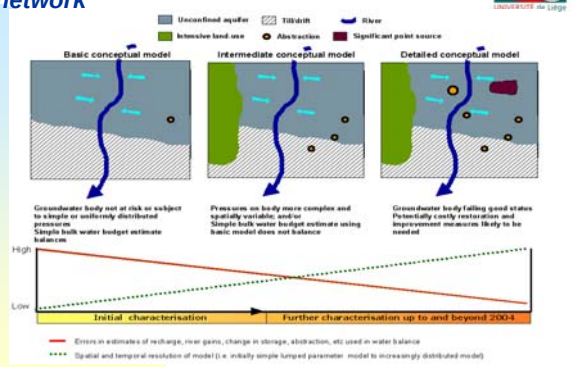
50 km

Hydrogéologie

Optimisation of groundwater monitoring network



Optimisation of groundwater monitoring network



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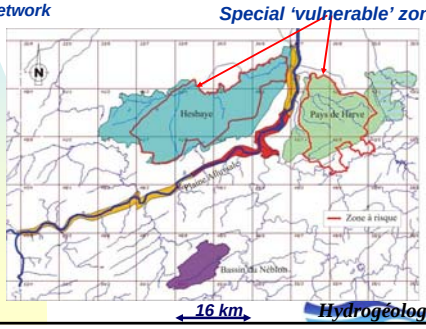
Optimisation of groundwater monitoring network

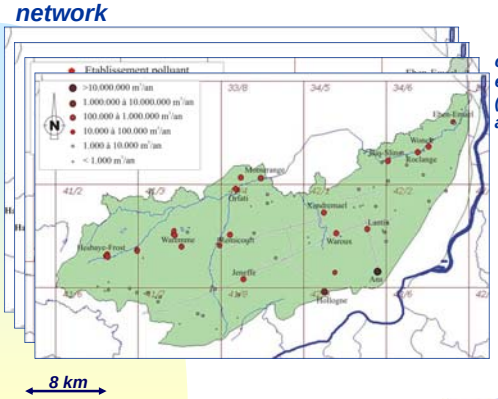
- *collecting all existing data (quantity and quality)*
- *analysis of geological/hydrogeological conditions*
- *on the basis of few criteria: choice of the points for the monitoring network*

Special 'vulnerable' zones



Hydrogéologie

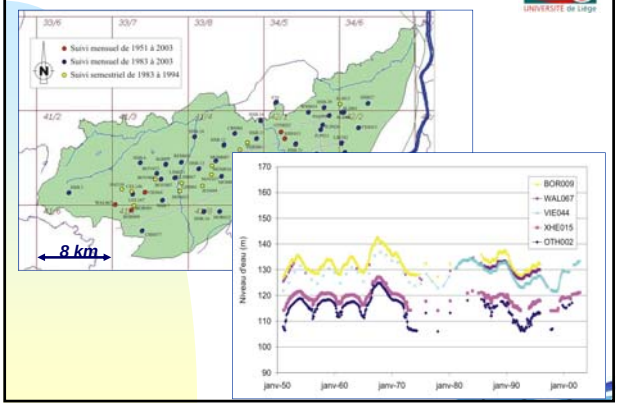
Optimisation of groundwater monitoring network



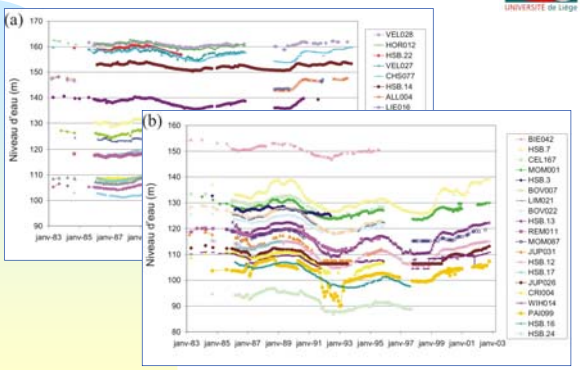
collecting all existing data (quantity and quality)

Hydrogéologie

Optimisation of groundwater monitoring network

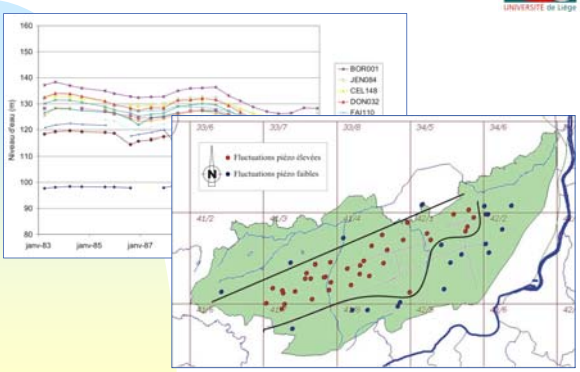


Optimisation of groundwater monitoring network



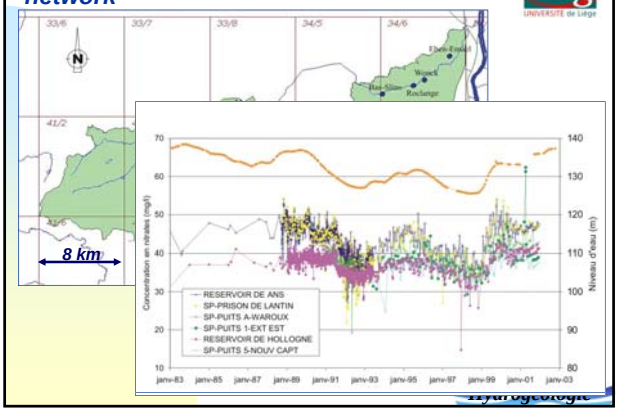
Hydrogéologie

Optimisation of groundwater monitoring network



Hydrogéologie

Optimisation of groundwater monitoring network



Hydrogéologie

Optimisation of groundwater monitoring network

analysis of geological/hydrogeological conditions

➡ *…on the basis of few criteria: choice of the points for the monitoring network*

- *upward or downward position of the measurement point (with respect to the piezometry)*
- *integrating/representative character of the measurement/sampling point*
- *variability of the historical measured data*
- *point contamination sources*
- *accessibility of the measurement/sampling point*
- *well equipment*
- *present state and ownership of the well*
- *depth*
- *…*

1 point/25km² in special zones and 1 point/100 km² in other zones

Hydrogéologie

Optimisation of groundwater monitoring network

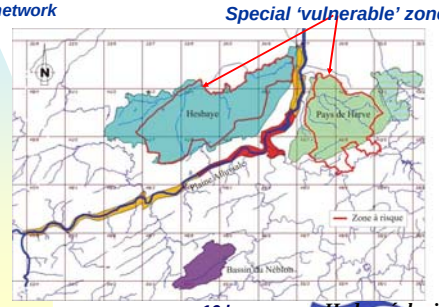
1 point/25km² in special zones and 1 point/100 km² in other zones

Hydrogéologie

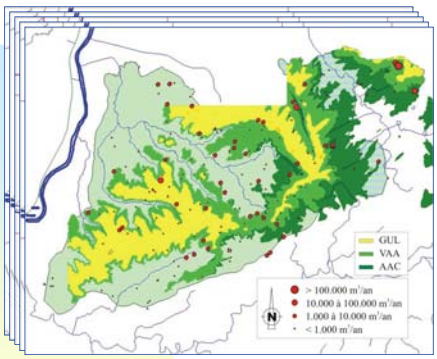
Optimisation of groundwater monitoring network

- collecting all existing data (quantity and quality)
- analysis of geological/hydrogeological conditions
- on the basis of few criteria: choice of the points for the monitoring network

Special 'vulnerable' zones

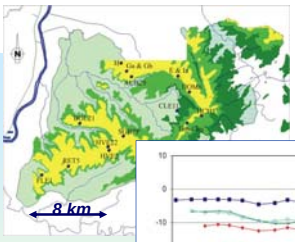


Hydrogéologie

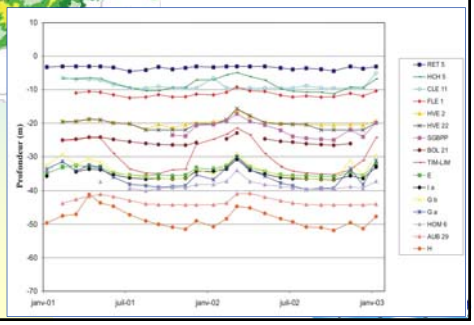


collecting all existing data (quantity and quality)

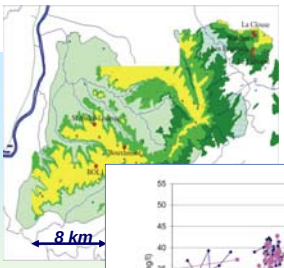
Hydrogéologie



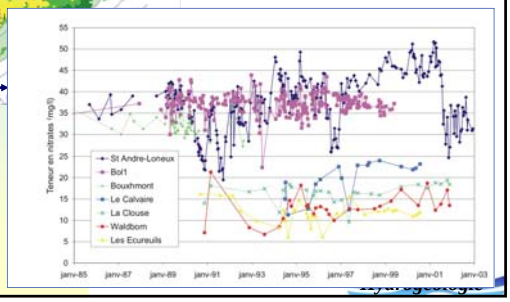
GW levels: quantity control



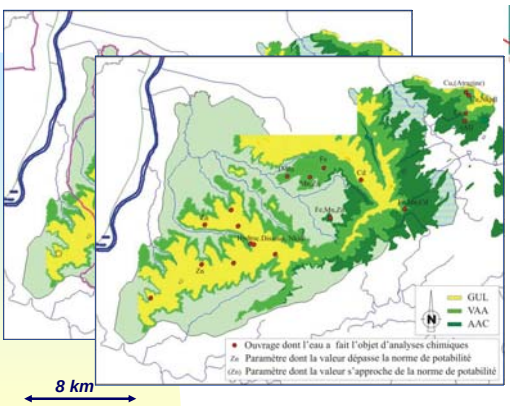
Hydrogéologie



GW concentrations: quality control



Hydrogéologie



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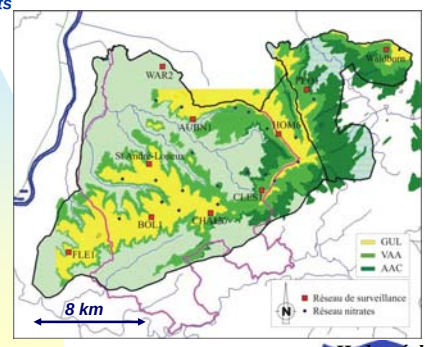
Optimisation of groundwater monitoring network

1 point/25km² in special zones and 1 point/100 km² in other zones

10 points

- *2 galleries*
- *1 source*
- *7 wells*



Hydrogéologie

Test of the SEQ-ESO as a groundwater quality evaluation tool

Objectives

- *check the groundwater quality with respect to the existing standards (nitrates, pesticides, …)*
- *check the drinking water standards without heavy processing at the source (resource)*
- *check the quality objectives for the depending surface ecosytems*
- *check anomalies with respect to the 'natural state' and to the present background*

then select the most difficult objective for synthesis, conclusions and remediation

'Système d'Evaluation de la Qualité des Eaux Souterraines' (SEQ-ESO) developed by the French 'Agences de l'Eau'

- *coherent with SEQ for surface water quality*
- *evaluation in function of the use*
- *distinction between different kinds of water quality 'alterations'*

Hydrogéologie

Test of the SEQ-ESO as a groundwater quality evaluation tool

- *17 different possible alterations … receiving a score between 0 and 100*
- *3 main functions of groundwater: consumed water (different kind of use), patrimonial state, chemical aptitude for biology of surface waters*

Adaptations:

only three kinds of index:

1) drinking water;

2) patrimonial state;

3) global

six groups of alteration

modification of some thresholds (gw quality limits between two categories)

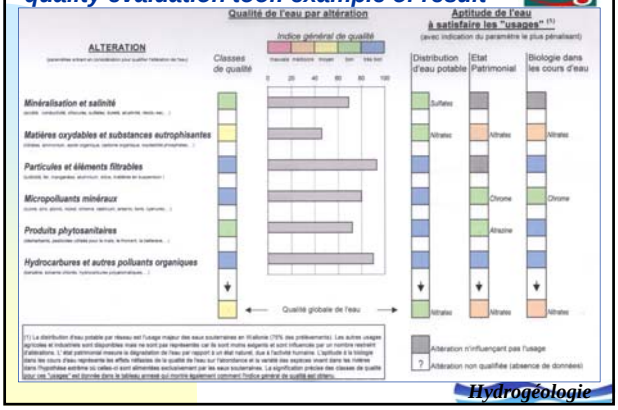
Hydrogéologie

Test of the SEQ-ESO as a groundwater quality evaluation tool

Usage AEP (alimentation en eau potable):		Indice global SEQ:				Etat patrimonial:
Eau de **qualité optimale** pour être consommée	NO3 = 25 mg/l	I= 80%	NO3=10	Eau de très bonne qualité	NO3=10mg/l	Eau dont la composition est **naturelle** ou "sub-naturelle".
Eau de **qualité acceptable** pour être consommée mais pouvant le cas échéant faire l'objet d'untraitement de désinfection.		I = 60%	NO3=20	Eau de bonne qualité	NO3=20mg/l	Eau de composition proche de l'état naturel, mais détection d'une **contamination** d'origine anthropique.
	NO3=50mg/l	I = 40%	NO3=50	Eau de qualité moyenne	NO3=50mg/l	**Dégradation significative** par rapport à l'état naturel.
Eau **non potable** nécessitant un traitement de potabilisation	NO3=100mg/l	I = 20%	NO3=100	Eau de qualité médiocre	NO3=100mg/l	**Dégradation importante** par rapport à l'état naturel.
Eau **inapte** à la production d'eau potable		I = 0%		Eau de mauvaise qualité		**Dégradation très importante** par rapport à l'état naturel.

Hydrogéologie

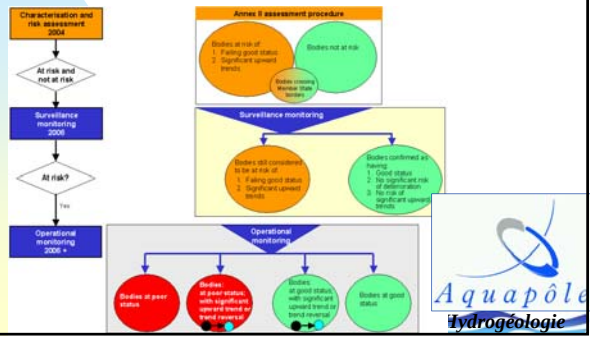
Test of the SEQ-ESO as a groundwater quality evaluation tool: example of result



Hydrogéologie

Conclusions: … a lot of work !!

the choices and the work done now will have a enormous influence on the future management of the groundwater bodies !



Hydrogéologie

Large-scale groundwater modelling within the PIRENE programme in the Walloon Region of Belgium

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[3] Groundwater Direction, Water Division, DGRNE Walloon Region, Belgium

Hydrogéologie

Quantitative and qualitative objectives

- Collect of data and using existing characterization of aquifers

Modelling groundwater quantity

- Hydrogeological balance of the aquifers
- Effect of the infiltration fluxes
- Estimation of groundwater-river interactions
- Impacts of pumping, recharge, … and any changes in stress-factors
- Trends of the groundwater quantity for different scenarios of the future

Modelling groundwater quality

- Trends in nitrates and pesticides
- Effect of the infiltration fluxes
- Estimation of groundwater-river interactions
- Impacts of any change in stress-factors

Hydrogéologie

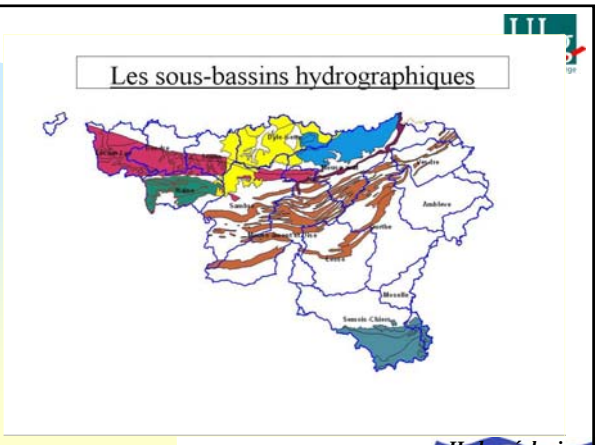
Methodology of work

Modelling groundwater flow and transport at an unusual scale: the scale of the Walloon Region

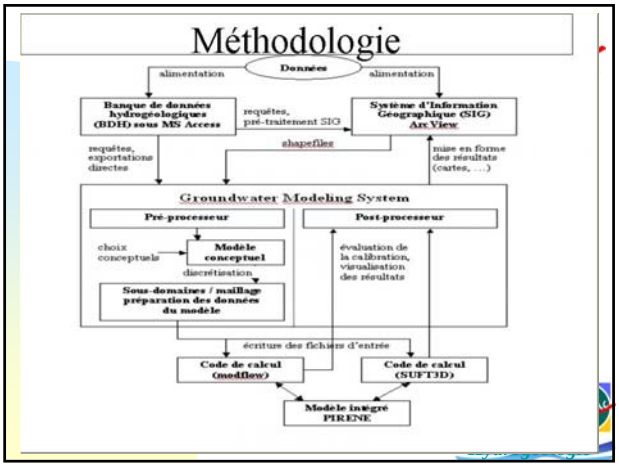
5 different steps:

- Collect of data
- Data Base and formating data
- Development of numerical tools adn tests
- Conceptual model for each zone
- Implementation of the chosen model, calibration, validation and use for scenarios

Hydrogéologie



Hydrogéologie



Adaptation of the SUFT3D code

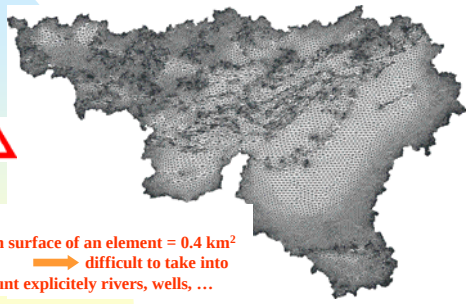
Modelling groundwater flow and transport at an unusual scale: the scale of the Walloon Region

- simplified approaches
- development of new boundary conditions
- improvement of computation performances

		TRANSPORT		
		Réservoir linéaire simple	Modèle de mixage distribué	Advection-dispersion
ÉCOULEMENT	Réservoir linéaire simple	OK	impossible	impossible
	Réservoir linéaire distribué	OK	OK	impossible
	Écoulement en milieu poreux	OK	OK	OK

Hydrogéologie

Tests of a regional discretization



2D

Mean surface of an element = 0.4 km²

→ difficult to take into account explicitely rivers, wells, …

Hydrogéologie