Risk evaluation and managment desater

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Plan

I. 1. Groundwater pollution : Vulnerability and risk

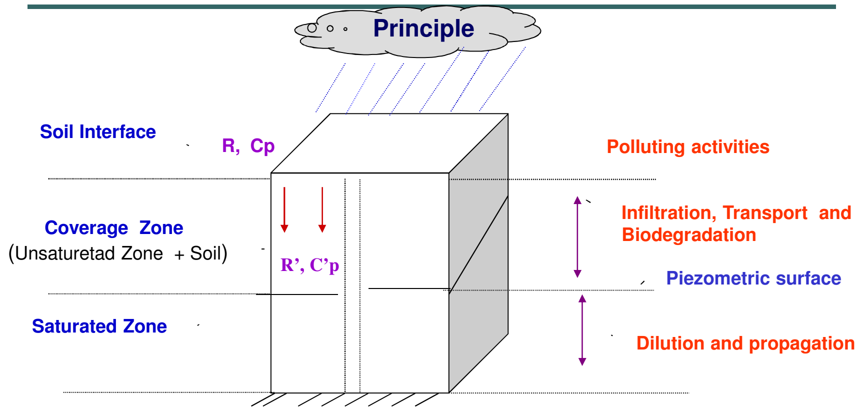


Fig. 1- Diagram of groundwater contamination

Risk ?

Definition:

- ***A more or less possible predictable danger; the hazard to incur a harm***
  Un danger éventuel plus ou moins prévisible ; le hasard d'encourir un mal **(Linguistiquement)**
- ***A mathematical esperance of possible damage***
  Une espérance mathématique de dommage possible **(Concept probabiliste des années 50)**
- ***A probability of damage***
  Une probabilité d'un dommage
- ***The crossing between vulnerability and unforeseen (probability)***
  Le croisement entre vulnérabilité et aléa **(Environnement)**
- ***The interaction between contaminant load and aquifer vulnerability***
  L'interaction entre la charge polluante et la vulnérabilité de l'aquifère **(Hydrogeologie)**

Foster, 1987 ; Brugnot, 1998 ; Arousseau, 1999

Evaluation of the pollution risk

Principle :

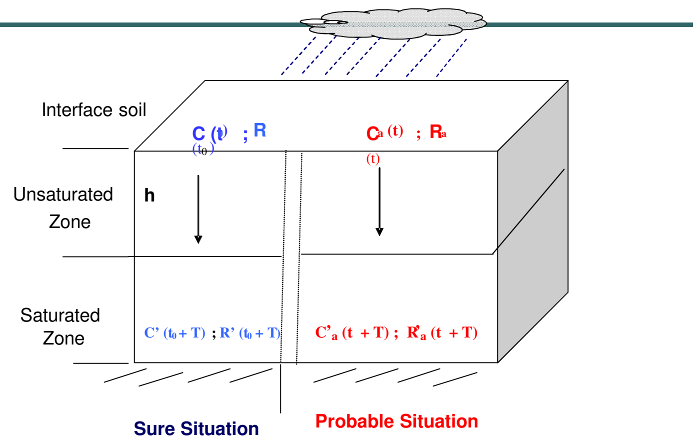


Fig. 2- Diagram of evalution of groundwater pollution risk

Evaluation of the pollution risk

Sure situation :

$C(t_0)$: Initial concentration
$C'(t_0 + T)$: Concentration in the arrival at the level of the tablecloth
T : Transit time

$$\text{Gravity } (t_0+T) = \alpha * C'(t_0 + T) \qquad (1)$$

α : Nature of the pollutant

Remark : Gravity depends on the **nature** and on the **dose** of pollutant in the waters of the aquifer

It is the dose which makes the poison
C'est la dose qui fait le poison (Paracelse, 1493 – 1541)

The concentration in the arrival at the tablecloth **$C'(t_0 + T)$** depends of the **initial concentration** **$C(t_0)$** and the **power purifier** **Md** of the coverage zone ;

$$C'(t_0 + T) / C(t_0) = \begin{cases} 1 - Md & \text{if } Md<1 \quad \text{case of partial purgation} \\ 0 & \text{if } Md \geq 1 \quad \text{case of complete purgation} \end{cases}$$

$$\text{Gravity } (t_0 + T) = \alpha (1 - Md) C(t_0) \quad \text{if } Md<1 \quad (2)$$

Remark:

- **Gravity $(t_0 + T)$** depend of the initial concentration **$C(t_0)$** and caractristics of polluant and of meduim
- Implicit relation between **gravity and vulnerability**

Md : **purifying power** *(Reshe, 1977)*

Evaluation of the pollution risk

Probable situation (aléatoire) :

Cp(t) : **Probable** initial concentration
C'p(t + T) : **Probable** concentration at arrival in the water of aquifer
T : Transit Time (**Certain**)

$$\text{Gravity p } (t + T) = \alpha * C'p\ (t + T) \quad (3)$$

$$\text{Gravity p } (t + T) = \alpha (1 - Md) Cp(t) \quad \text{if } Md<1 \quad (4)$$

Evaluation of the pollution risk

Or in the surface soil the evolution of use and / or rejection of pollutants
Cp (t) follows a law of evolution form :

$$\begin{cases} d\,Cp(t)/dt = fa\,(Cp(t)) & \text{for} \quad t > t_0 \\ Cp(t_0) = C(t_0) & \end{cases}$$

Where **fa** is a **function aleatoire** to be determined (**law of aleatoire evolution**)
Which gives **C'p(t +T)** and then the **probable gravity**

$$\textbf{Gravity } p\,(t + T) = \alpha\,(1 - Md)\,Cp(t) \qquad (4)$$

Remark : **Probable gravity = Risk**

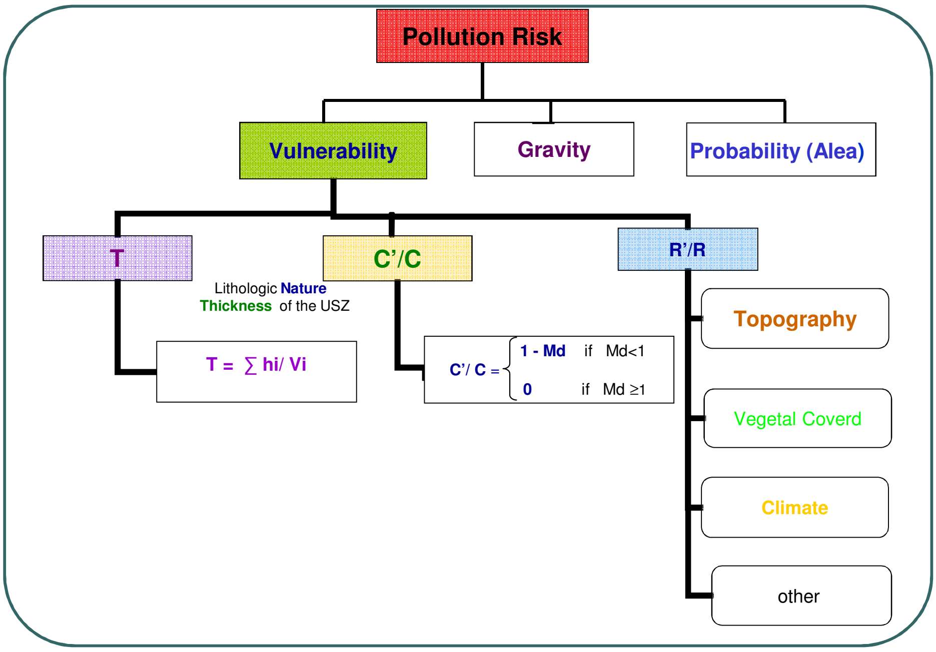
Qualitative / Quantitative approach of the pollution risk

$$\textbf{Gravity } p\,(t + T) = \alpha\,(1 - Md)\,Cp(t) \qquad \text{if} \quad Md<1 \qquad (4)$$

Risk = f (Gravity, Vulnerability, Probability)

- **Gravity** : depends on the **nature** and **dose** of pollutants
- **Vulnerability** : depends on the considered **medium**
- **Probability** : **law of evolution** of pollutants in the surface soil (**evolution of use** and /or **rejections** of polluant

The qualitative evaluation of the pollution risk requires the estimation of these three parameters



Vulnerability : TCR approach

Principle :

A zone is **vulnerable** if the polluting product reshed the groundwater at a **short time** and with a **high concentration**.

Vulnerability index **Iv = f (T, C, R)**

Vulnerability index :

$$Iv = \alpha\ 1/T + \beta\ C'p/Cp + \gamma\ R'/R$$

α, β and γ are coeficients (pondérateurs).

RemarK : The choose of α, β et γ : **sensibility tests**

M. Amharref et al./ Sciences Water Journal 20(2) (2007) , 185-199
A. Bernoussi. IJSS, 2007

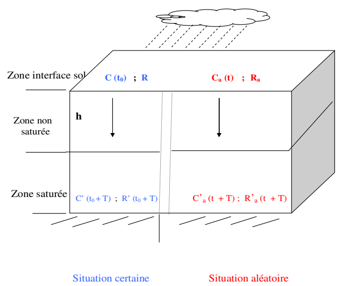
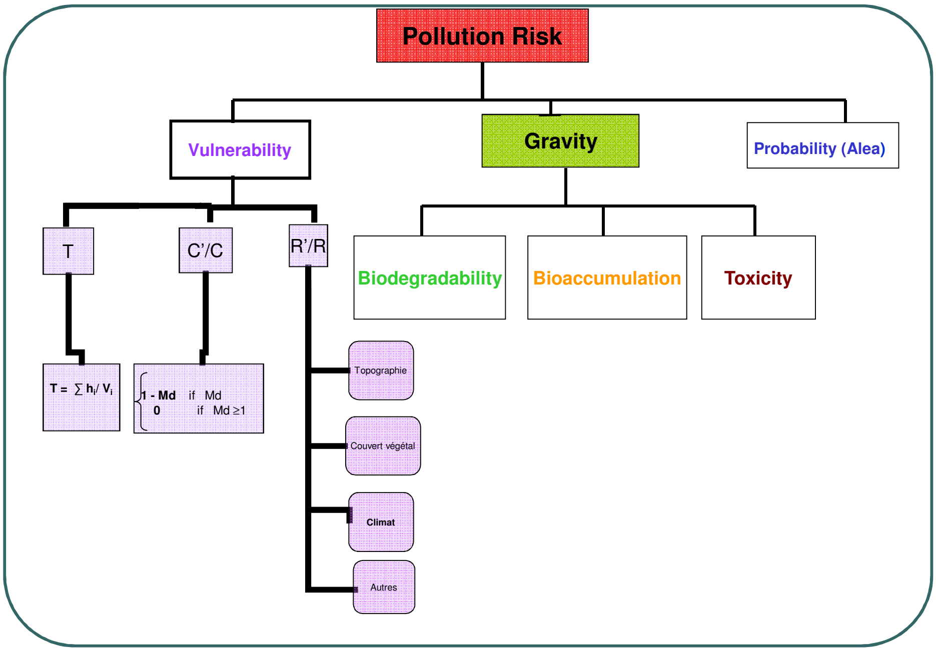


Fig. 2- Schéma d'évaluation du risque de pollution des eaux souterraines

Evaluation of vulnerability

- $1/T = V/h$ where V the filtration speed and h thickness of the coverage zone
- $$C'(t_0 + T) / C(t_0) = \begin{cases} 1 - Md & \text{if } Md<1 \\ 0 & \text{if } Md \geq 1 \end{cases}$$
- **R'/R : water balance sheet (bilan hydrique)**

M. Amharref et al./ Revue des Sciences de l'Eau 20(2) (2007) 185-199



Gravity

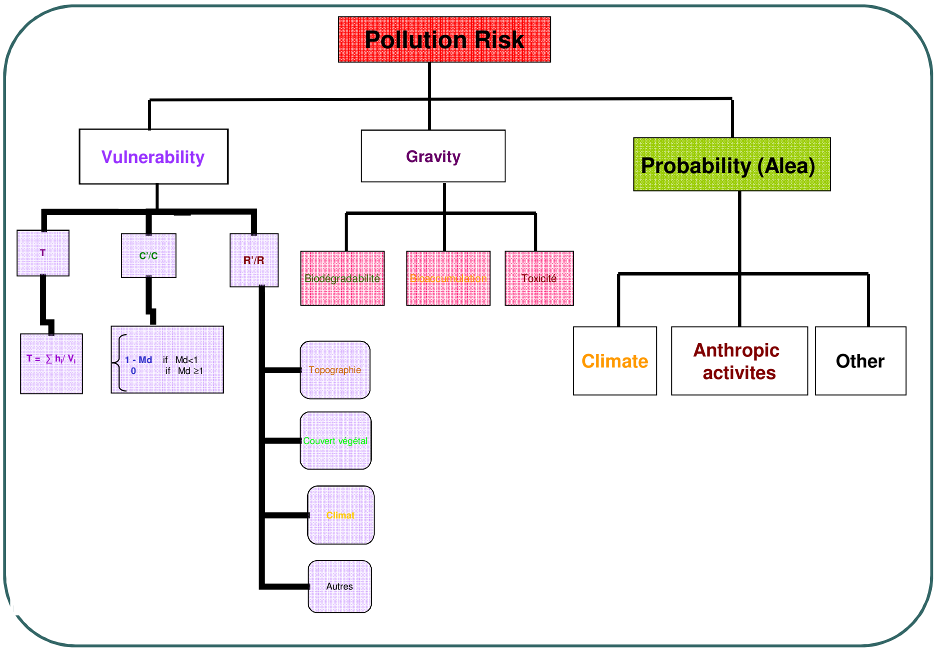
Garvity of a pollutant can be characterized : Biodegradability, bioaccumulation and toxicity

Gravity of a situation depends on the **nature** of pollutant and on the **concentration (C'p)** with polluting water arrives in tablecloth

$$\textbf{Gravity} = \alpha * C'(T)$$

$\alpha = 1/ S_n$: **Proper gravity** of each pollutant

It's deducted from **Standards norm** (S_n) (potable water-quality Guidelines) defined by WHO (Worldwide Organization of Health), or from law water for considered country

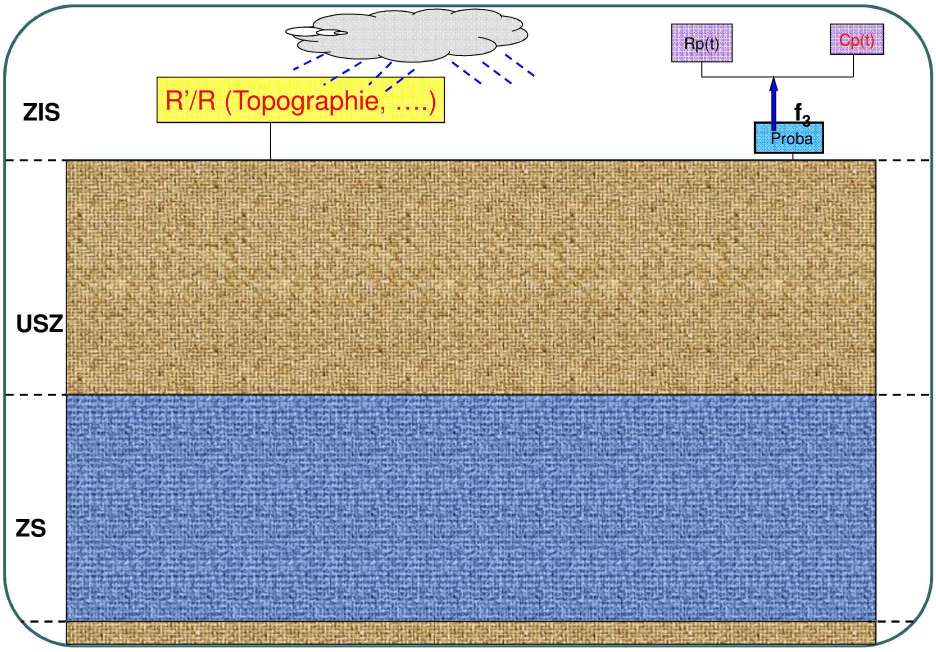


Probability (Alea)

Probability (groundwater pollution):

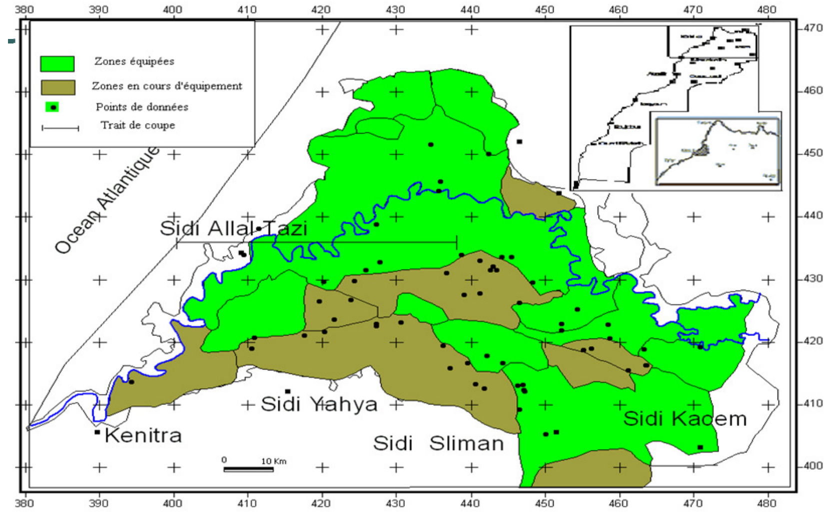
1- Evolution of use or rejected of pollutant (law of evolution for probable concentration **Cp (t) ?**)

2- Variation of probable recharge Rp (t) (law of evolution of irrigation and of infiltration de la pluie efficace : **Climatic change ?**)

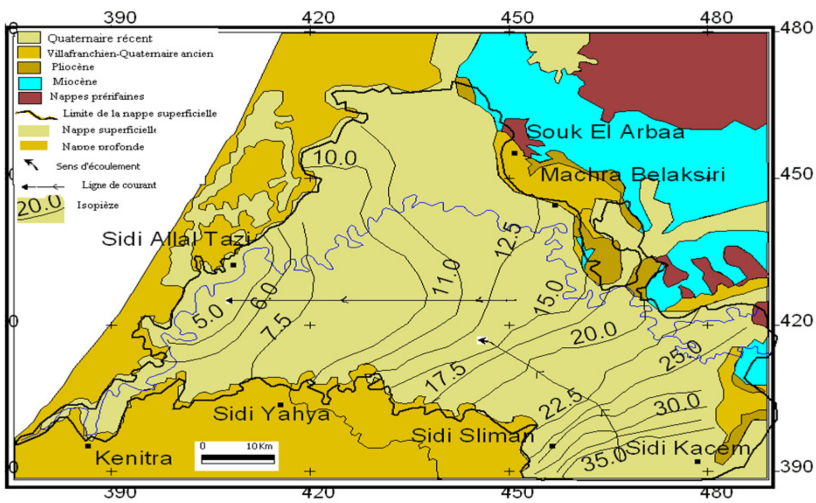


Application (Gharb's plain, Morocco)

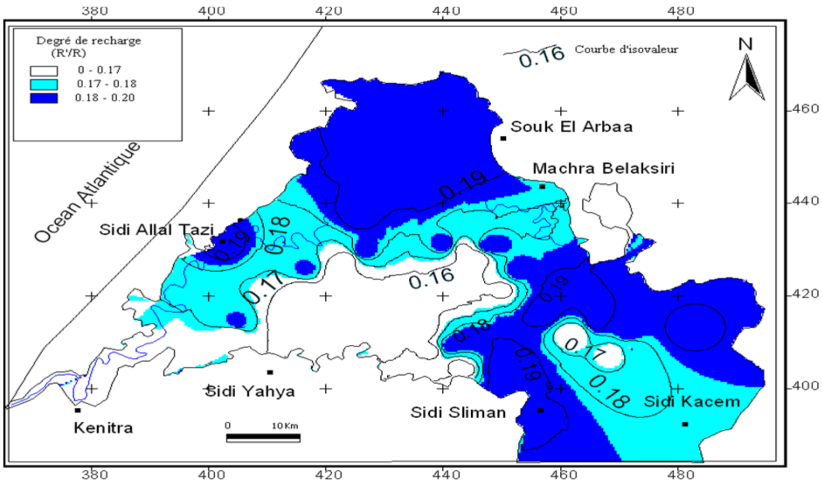
Distribution of data points and irrigated areas



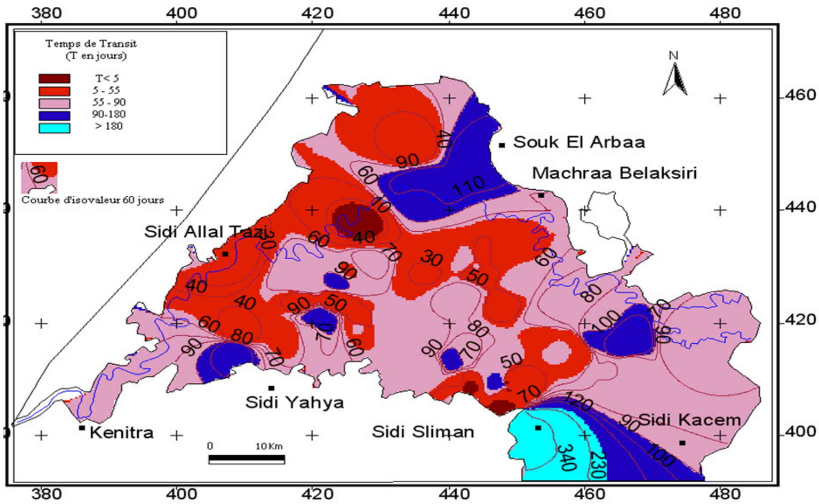
Piezometric Map



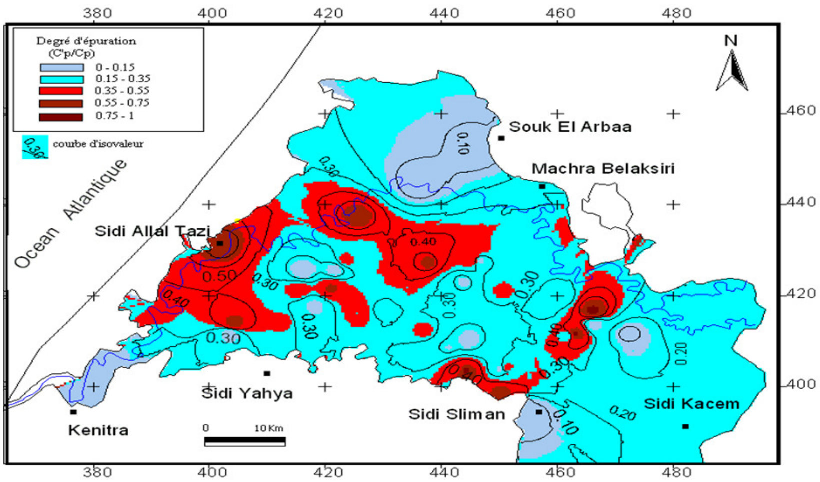
Degree of recharge map (R'/R)
(Topography, Soil nature and occupation, …)



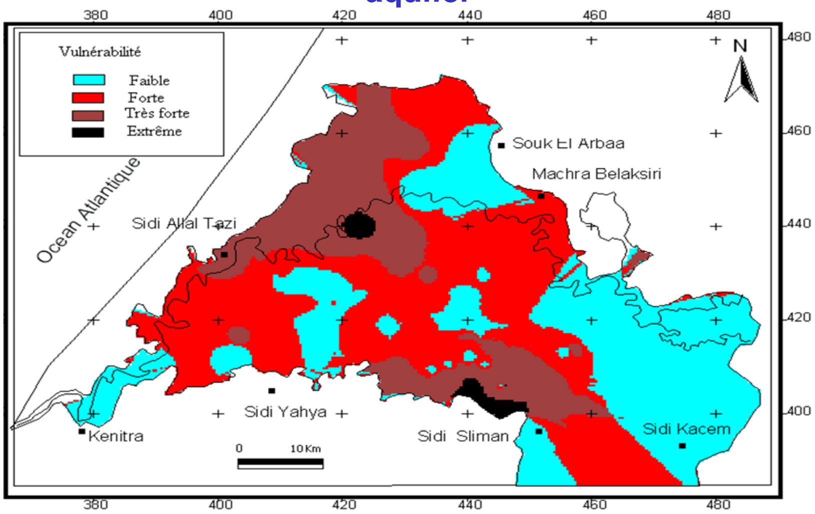
Transit Time map



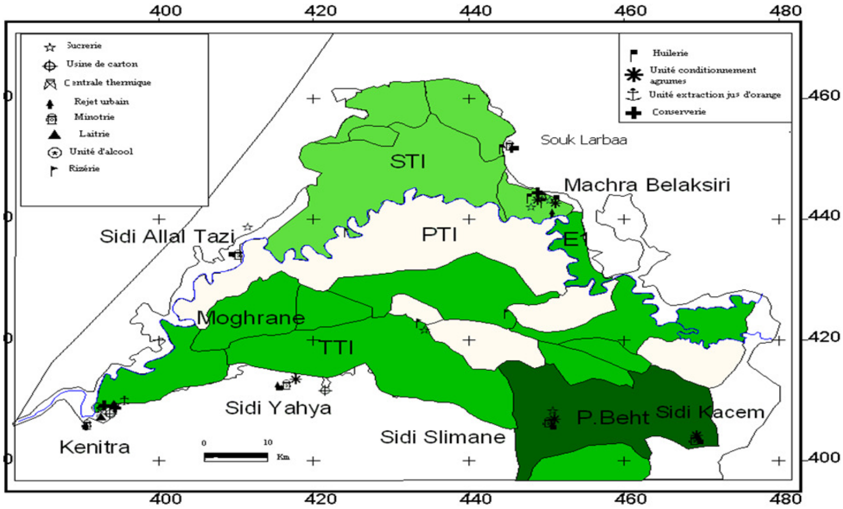
Purification degree map (C’p/Cp)



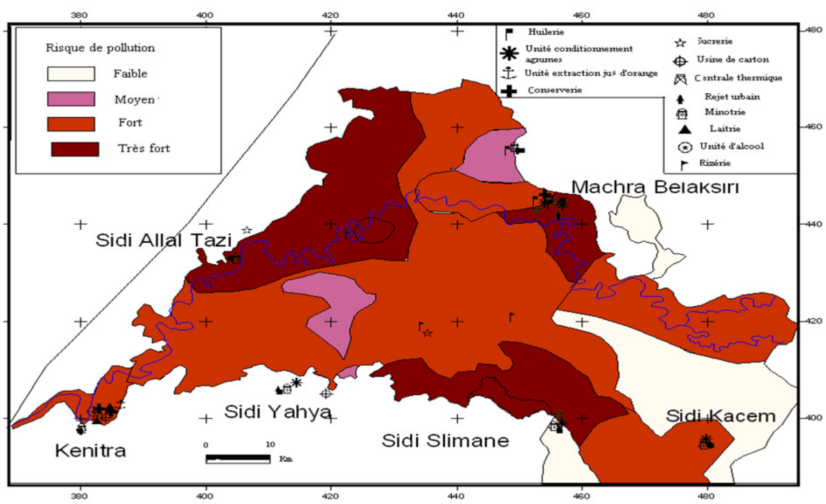
Intrinsic vulneability map of the Gharb shallow aquifer



Potentiel sources of pollution in the Gharb plain



Pollution risk map of the Gharb shallow aquifer



Flood Risk

Risk = f (Gravity, Vulnerability, Probability)

- **Gravity** : depends on the **nature and the intensity of flood dammage**
- **Vulnerability** : depends on the considered **medium and topography**
- **Probability** : **law of evolution** of precipitation **(climatic change)**

Other risk

- 1. Risk : error of modelisation;
- 2. Risk : error of measures

Applications (pollution ; flood) :
Topography: R'/R (pollution), Speed flow (Flood)

Risk due to error on estimation measures / Model

- Small error on the estimation of topography parameter ….. Big error on the final results (Nonlinearity of the system).
- Risk must take into account such errors.

Conclusion/ Recomandation

Ideal managment risk is with some risk !!!) : Pluridisciplinarity

I) 1. Try to prevent the unumprevisible (natural and techniques);

2. Consider many scenaries for a same situation (evolutive) : Non linar systems; chaotics.

II) 1. For known (or predictible) situations : Low (perimeters of protection (pollution)…, Autorisation of built (flood).

2. Umprevisible situation : encouraged scientific researchl

Prendre la responsabilité de gérer les risques… est très risqué… Mais il faut bien prendre le risque de le faire car si on ne fait rien… on est certain…qu'on va tout perdre un jour ou un autre !

Références

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Thank you

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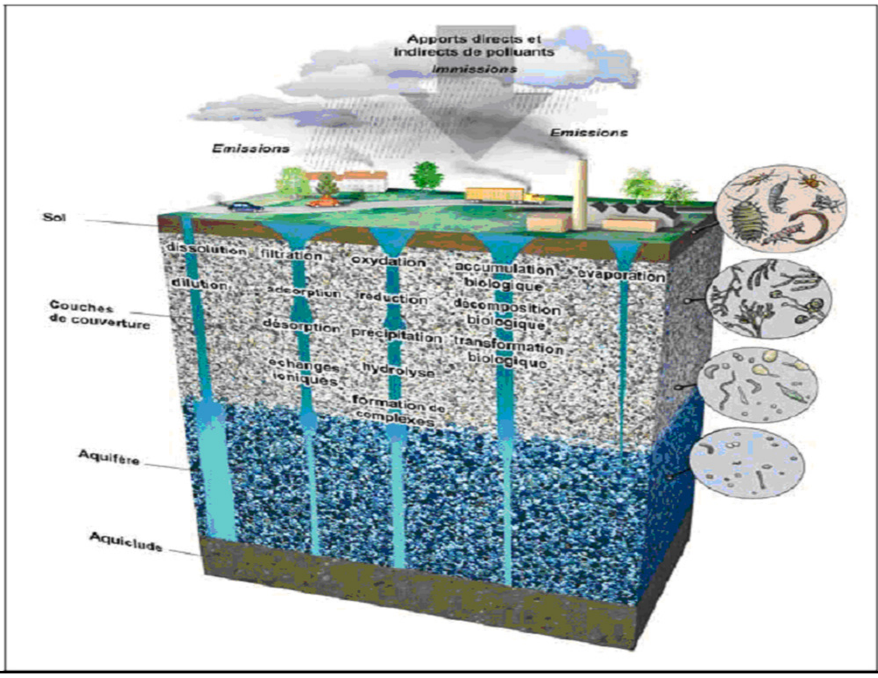
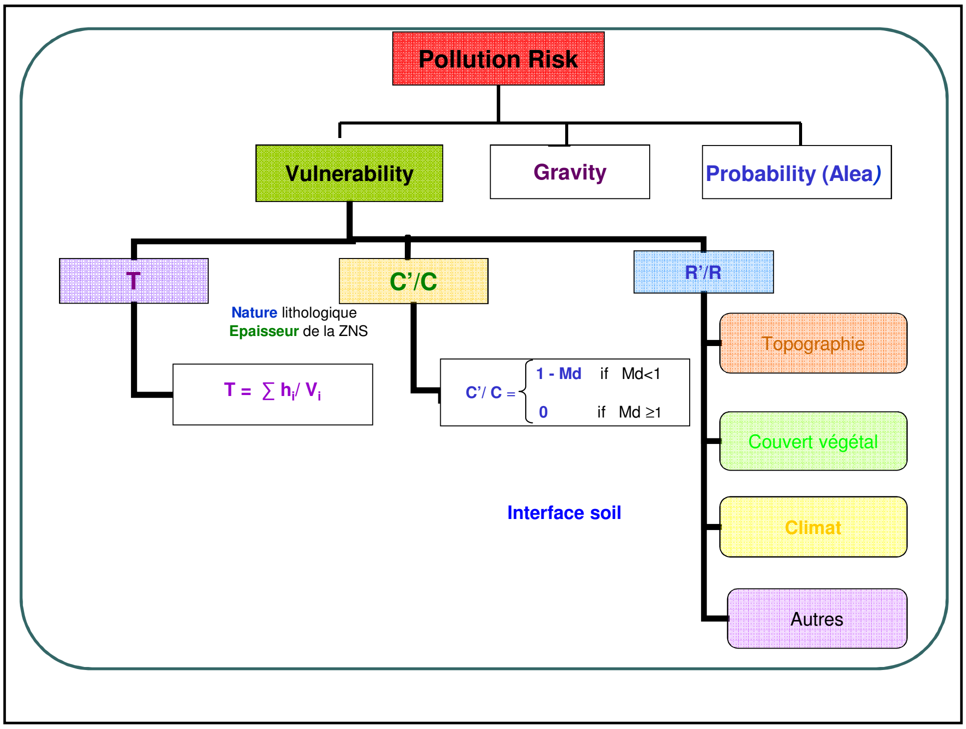
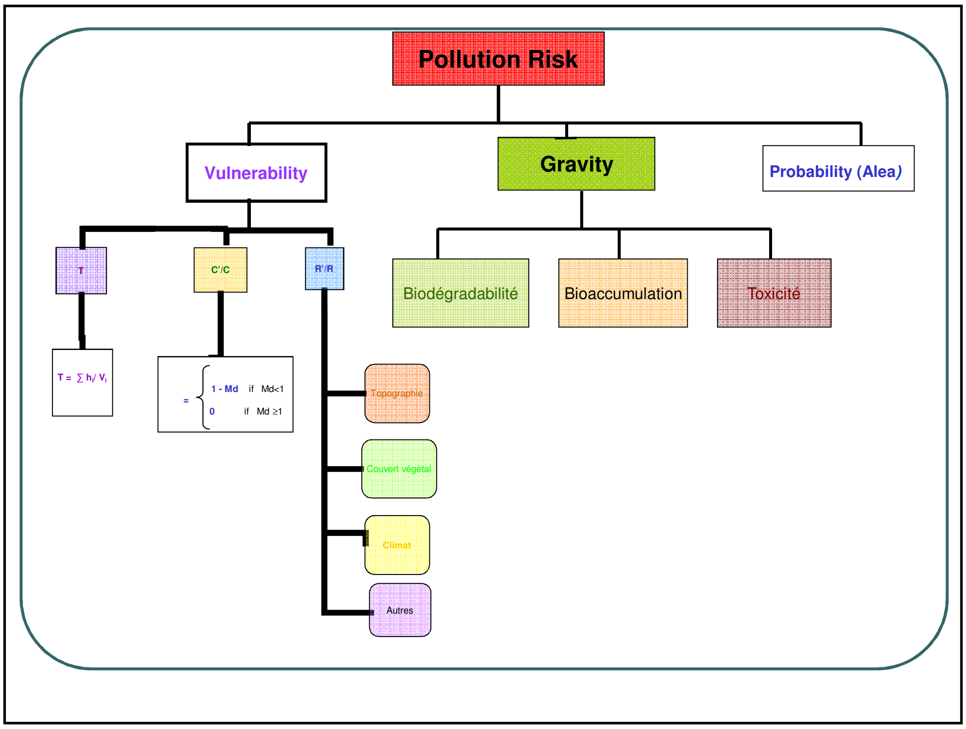



Pollution Risk
Vulnerability
Gravity
Probability (Alea)
T
C'/C
R'/R
Nature lithologique
Epaisseur de la ZNS
T = ∑ hi/ Vi
C'/ C = 1 - Md if Md<1
0 if Md ≥1
Topographie
Couvert végétal
Interface soil
Climat
Autres


Pollution Risk
Vulnerability
Gravity
Probability (Alea)
T
C'/C
R'/R
Biodégradabilité
Bioaccumulation
Toxicité
T = ∑ hi/ Vi
1 - Md if Md<1
0 if Md ≥1
Topographie
Couvert végétal
Climat
Autres

Qualitative evaluation of the gravity

Situation	1	2	3	4
Toxicity (CL50 en mg/l)	not very toxic CL50>100	moyennement toxin 10 < CL50< 100	toxin 1<CL50<10	very toxic CL50 <1
Bioaccumulation Facteur of accumulation	not much (très peu) F.ac < 5. 10^2	not much (peu) 5. 10^2 < F.ac < 10^3	medium 10^3 < F.ac < 10^4	high F. ac >104
Biodegradation	very easy > 80 %	easy de 60 à 80 %	medium de 40 à 60 %	weak < 20 %
Gravity	weak	medium	strong	very strong

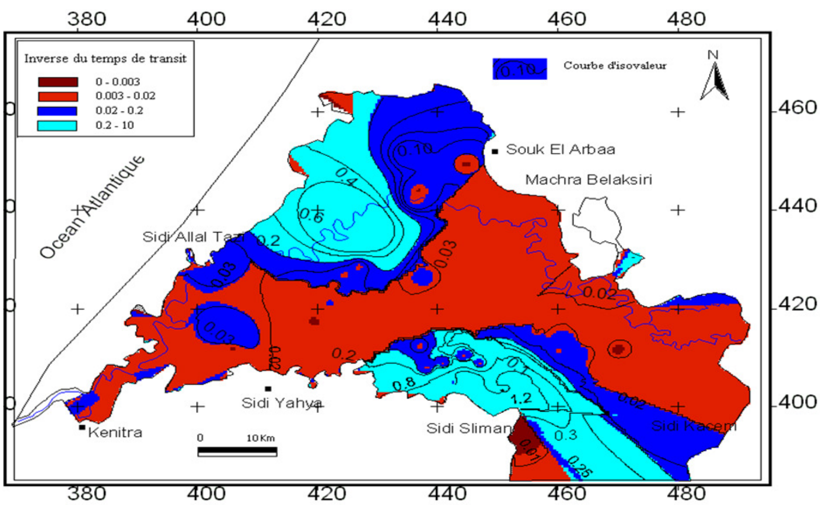
Tab 1. Parameters caracterising the gravity of a pollutant

Gravity / vulnerability

Vulnerability / Gravity	Weak	Medium	Strong	Very strong
Weak	weak	weak	medium	medium
Medium	weak	medium	strong	strong
Strong	medium	strong	very strong	very strong
Very strong	strong	strong	very strong	very strong

Tab 2. Coupling effect of the gravity and vulnerability

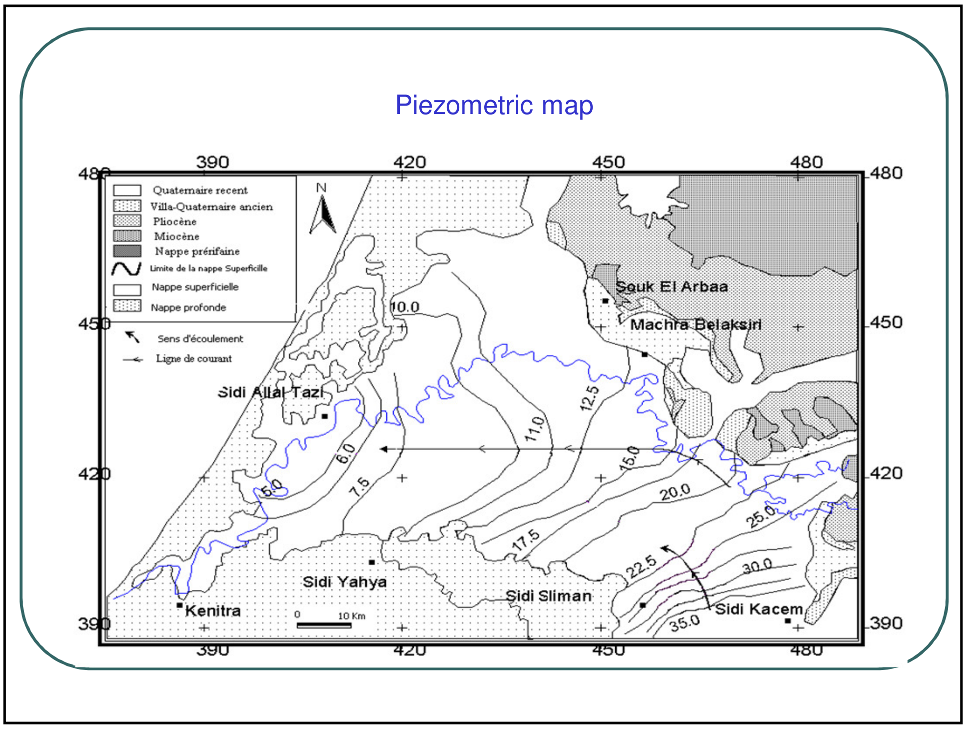
Transit Time map (1/T)



Qualitative aproach of the risk:
Risk = f(Probability, Vulnerability, Gravity)

Probability / Gravity/Vulnerability	Very weak	Weak	Strong	Very strong
Weak	weak	weak	medium	medium
Medium	weak	medium	strong	very strong
Strong	medium	strong	very strong	very strong
Very strong	medium	strong	very strong	very strong

Tab 3. Qualitative estimation of risk


Piezometric map
Quaternaire recent
Villa-Quaternaire ancien
Pliocène
Miocène
Nappe prérifaine
Limite de la nappe Superficille
Nappe superficielle
Nappe profonde
Sens d'écoulement
Ligne de courant
N
Souk El Arbaa
Machra Belaksiri
Sidi Allal Tazi
Sidi Yahya
Sidi Sliman
Sidi Kacem
Kenitra
0 10 Km
390
420
450
480
5.0
6.0
7.5
10.0
11.0
12.5
15.0
17.5
20.0
22.5
25.0
30.0
35.0