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Centre d'études et d'expertise sur les risques,  
l'environnement, la mobilité et l'aménagement

# HUMAN HEALTH RISK ASSESSMENT GUIDANCE FOR DREDGING AND DISPOSAL AT SEA OF MARINE AND ESTUARINE SEDIMENTS

**Background and Objectives**

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**Human health risk assessment**

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**Chemical Risk**

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**Biological Risk**

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# Background

- **Regulation :**

- For projects subject to an Environmental Impact assessment, a human health risk assessment has to be done ;

- For projects submitted to the Water Act, the analysis of health impacts is recommended.

- **General :**

Differences in the consideration of the human health risk assessment.



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# Objectives

The working Group on dredging and environment (GEODE) decided to produce this guide in order to :

- ***provide a common frame of reference to :***
  - *Administrations,*
  - *Port authorities,*
  - *Consultancy companies.*
- ***Harmonize practices.***



## HHRA : Keys Concepts

**Hazard** : corresponds to inherent properties of a physical, chemical or biological factor which can affect human health.

**Exposure** : refers to the contact between a physical, chemical or biological factor which can affect human health ;

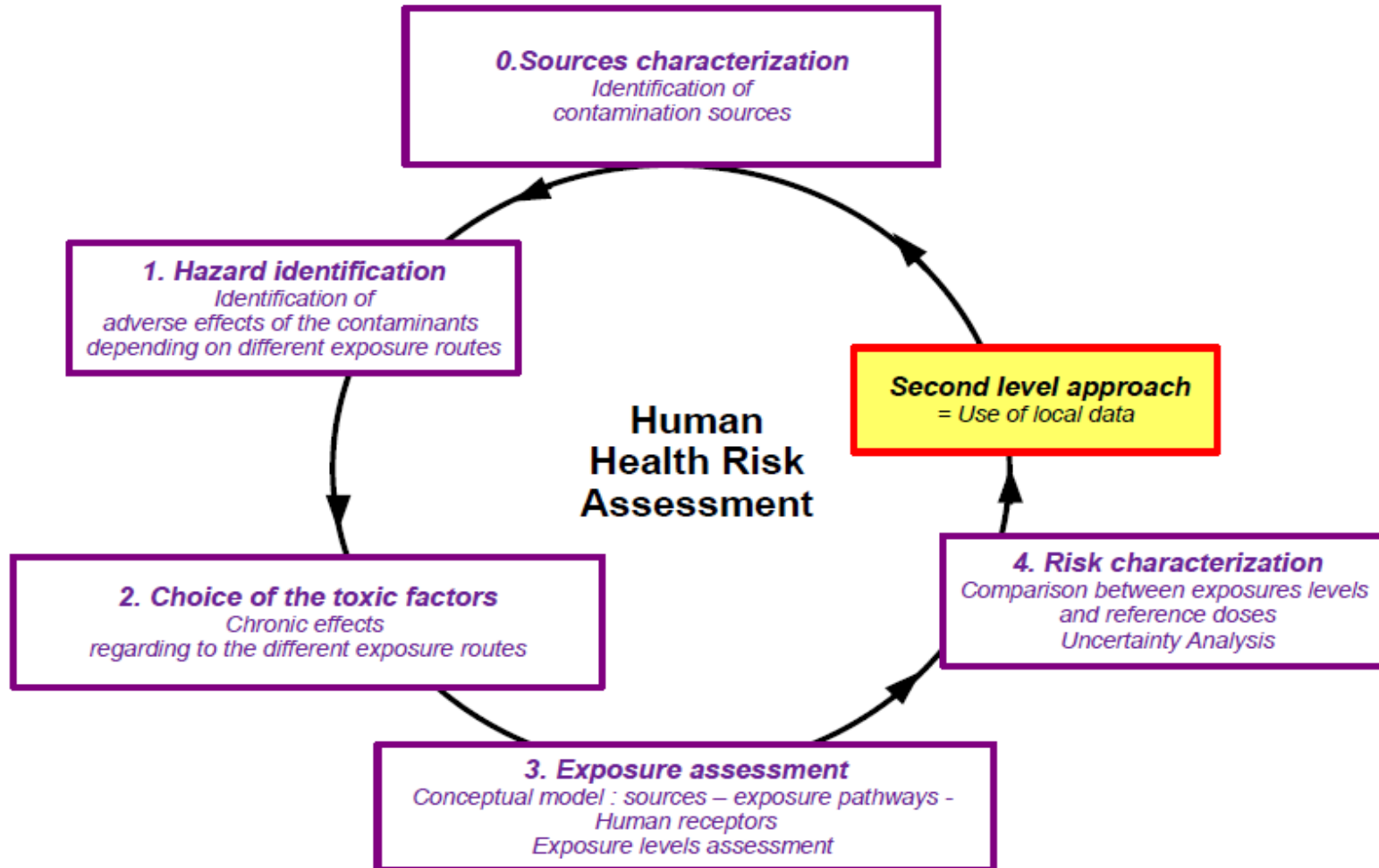
**Toxicity factors (TF)**: these values define exposure level that correspond to an appreciable risk of adverse effects.

**Health risk** corresponds to the probability of a disease occurrence for a person or a population in a defined period.

$$\text{Risk}_{\text{Hazard}} = f_{\text{Hazard}} (\text{Exposure}, \text{TF})$$



## HHRA : Methodology





## Chemical Risk : site initial state data

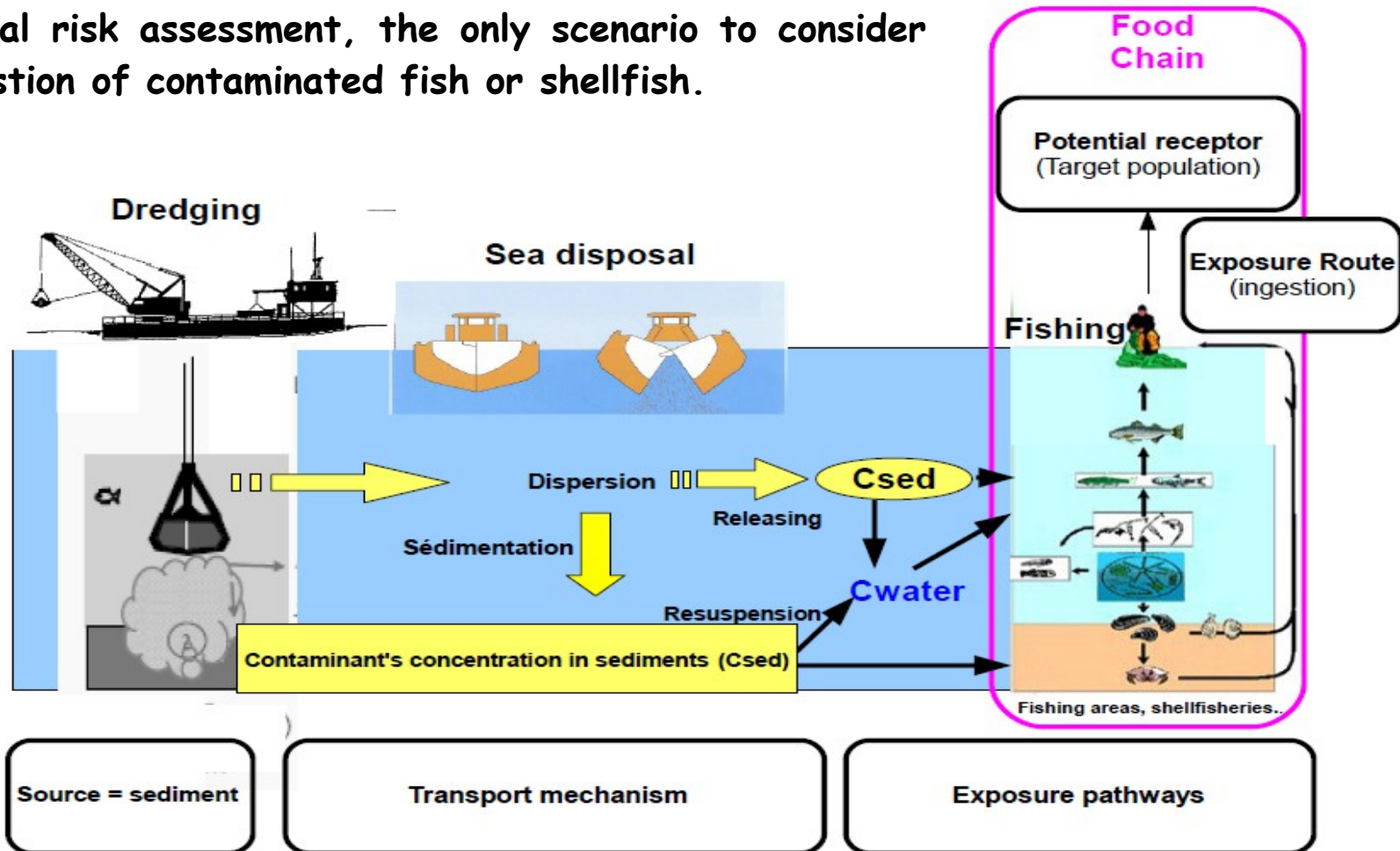
In the context of dredging and sea relocation of harbour sediments, many data from the site initial state can be use for HHRA :

- **Potential targets** : shellfishery and fishing areas, aquatic and nautical recreational activities...;
- **Contaminants of concern** : chemical characterization of dredged sediments and presence of specific emissions ;
- **Exposed area** : Characteristics of dredging techniques, physical properties of sediments and local hydrodynamic conditions allow to evaluate the dispersal of particles (turbidity plume).



## Chemical Risk : conceptual model

The conceptual model defines individual risk scenarios.  
For chemical risk assessment, the only scenario to consider  
is the ingestion of contaminated fish or shellfish.









## Chemical Risk : contaminants of concern

*The chemical compounds identified for having human health effects have been classified with decreasing importance in four categories. :*

List 1 : Contaminants with regulations about their concentration in seafood	List 2 : Contaminants with recommendations about their concentration in seafood	List 3 : Priority chemical substances in marine environment with toxic factors	List 4 : Contaminants that may be found in marine environment connected to agricultural river basins with toxic factors
Arsenic Cadmium Lead Mercury Benzo(a)pyrene PCB i (CB 28, 52, 101, 118, 138, 153, 180) PCB-DL, dioxins, et furans Hexachlorobenzene	Anthracene Fluoranthene Dibenzo(a,h)anthracène Benzo(b)fluoranthene Benzo(ghi)pérylene Benzo(k)fluoranthene Indéno(1,2,3-cd)pyrène Chrysene Benzo(a)anthracene	Pyrene Phénanthrene Nickel Lindane Tributyltin (TBT)	Dieldrin

Among these chemicals, metallic compounds, PCB, TBT and PAHs are routinely analysed on sediments in dredging projects.



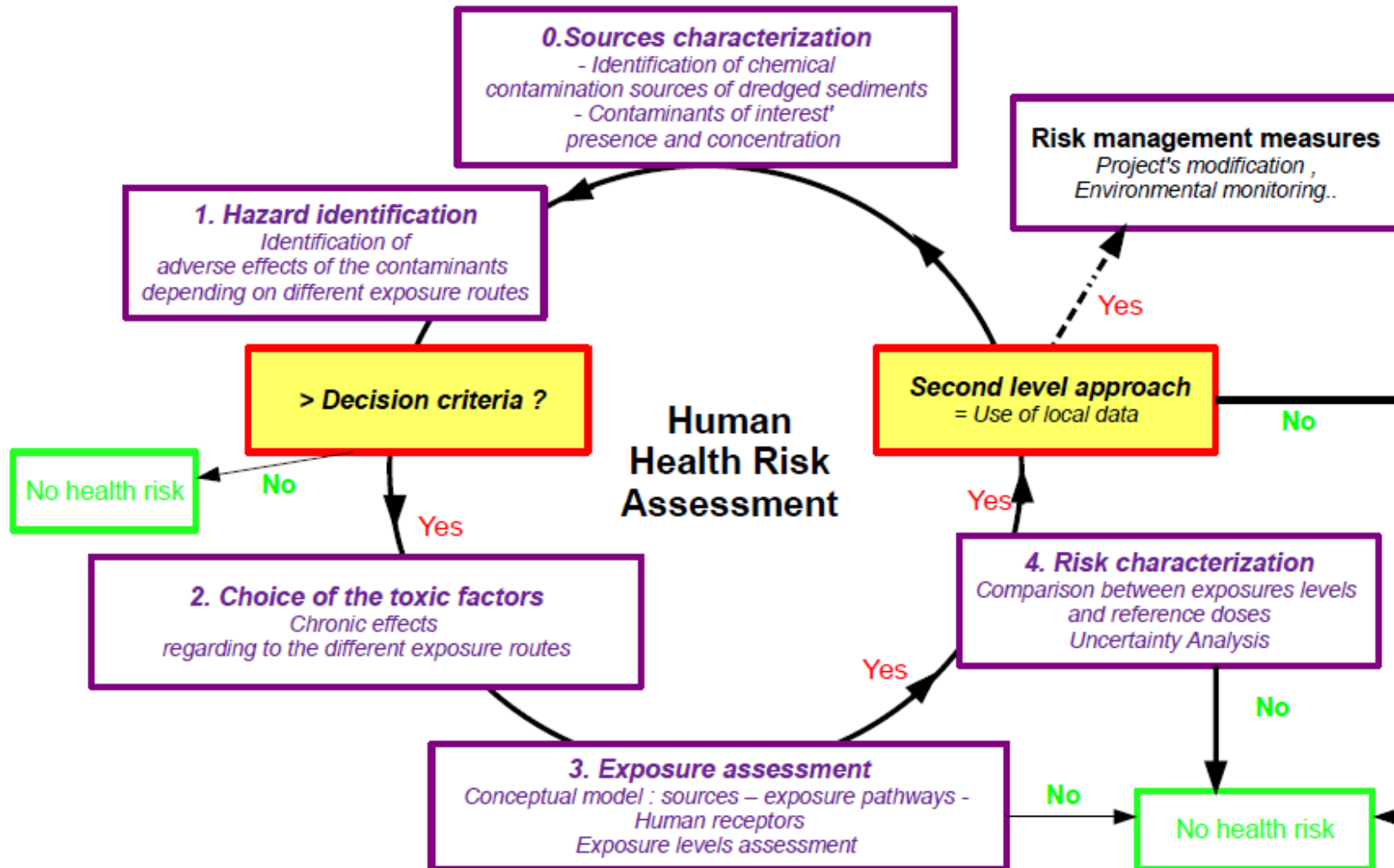
## Chemical Risk : decision criteria

Benchmark values of contaminant's concentrations in sediments have been calculated using the equilibrium partitioning method of the European Technical Guidance Document (TGD)

Regulatory analysis for dredging operations		
Substances	List	Indicative threshold value
Cadmium	1	22 mg/kg p.s.
Lead	1	968,5 mg/kg p.s.
Σ 6 PCB indicators	1	25 µg/kg p.s.
PCB-DL + dioxins	1	1,8 µgTEQ/kg p.s.
PCB-DL	1	0,84 µgTEQ/kg p.s.
Benzo(a)pyrene	1	1,84 mg/kg p.s.
Σ 11 HAP	2	1,84 mg TEQ/kg p.s.
Pyrene	3	12,85 mg/kg p.s.
Phenanthrene	3	21,8 µg/kg p.s.
Nickel	3	15 mg/kg p.s.
Tributyltin (TBT)	3	0,26 µg/kg p.s.
Other analysis		
Hexachlorobenzene	1	2,9 µg/kg p.s.
Lindane	3	25,6 µg/kg p.s.
Dieldrin	4	1,426 mg/kg p.s.



## Chemical Risk : quantitative risk assessment





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# Biological Risk : Qualitative Risk Assessment

**The assessment of biological risk is different from the chemical risk assessment:**

- *the lack of data and methods of environmental concentration assessment only allows to realize a **qualitative assessment** ;*
- *effects are principally acute.*



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# Biological Risk : microbiological contamination

## Risk assessment

- ▶ *It is necessary to consider **bacteria, virus and pathogenic protozoa**;*
- ▶ *The possible exposure routes are **ingestion, inhalation, and skin contact**.*
- ▶ *The effects induce by microbiological organisms could be **acute or chronic**.*



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# Biological Risk : microbiological contamination

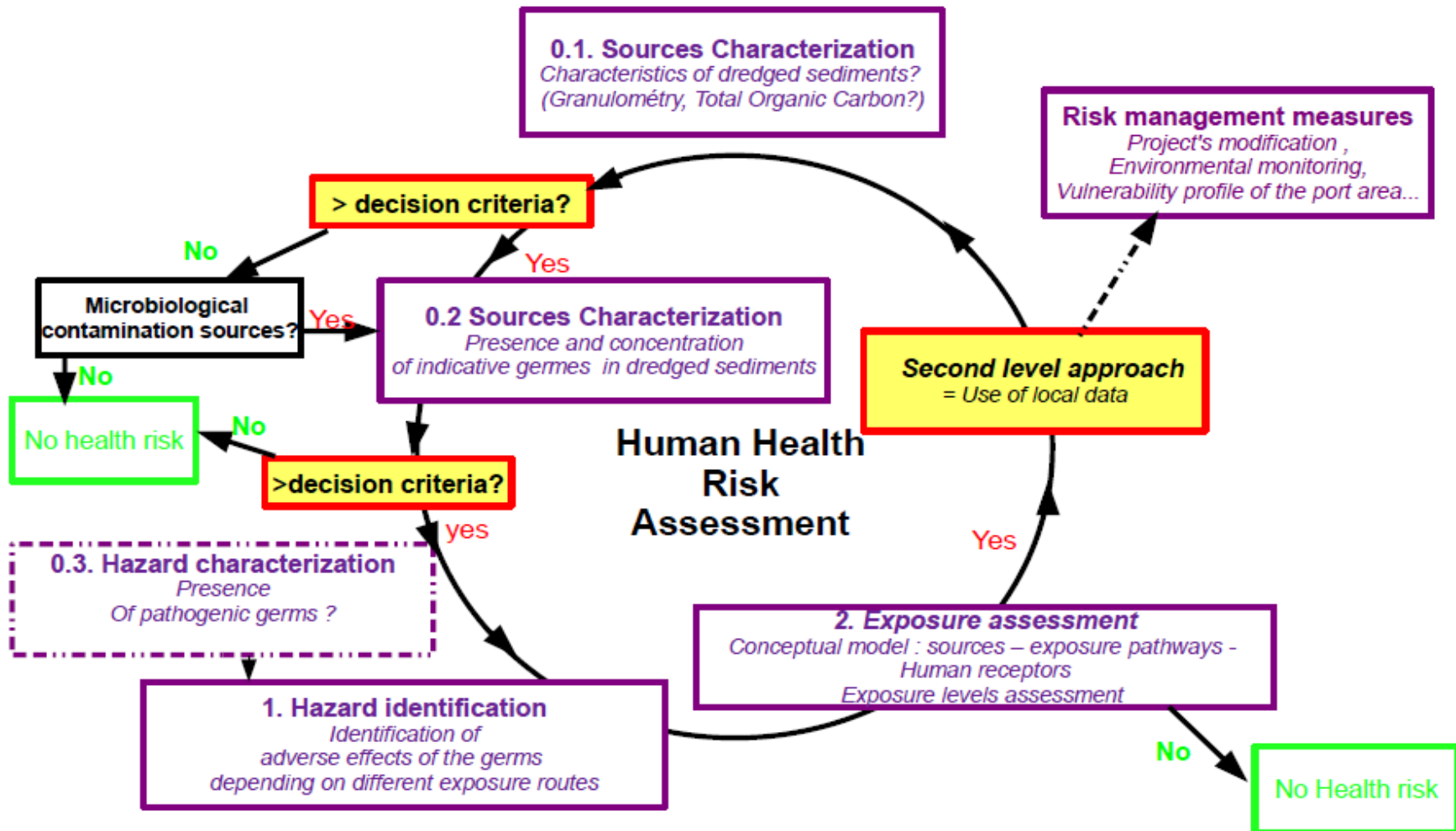
## Decision criteria

- ▶ *The first decision criteria is the fecal indicator germs concentration (*E.coli* > 10000/100g dry sediment and enterococci > 4000/100g dry sediment) ;*
- ▶ *In addition, several **physical and chemical characteristics** of sediments could give an indication on a possible microbiological contamination (grain size distribution of sediment (< 5µm, organic matter content > 4%).*

*In some cases, a direct analysis of **pathogenic germs** like salmonella, for example, could be necessary.*



## Biological Risk : microbiological contamination





## Biological Risk : toxic phytoplankton contamination

### Risk assessment

- ▶ *In metropolitan France, three species of toxic phytoplankton are a matter of concern for human health : **Dinophysis**, **Alexandrium** and **Pseudo-nitschia**.*
- ▶ *The transport mechanism is the dispersion of phytoplankton cysts potentially present in sediments. Then, only the phytoplankton capable of producing cysts like **Dinophysis** and **Alexandrium** should be considered.*
- ▶ *The principal exposure route is the ingestion of contaminated seashell or fish.*
- ▶ *The main effects of phycotoxins are acute.*





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# Biological Risk : toxic phytoplankton contamination

## Decision criteria

- ▶ *The decision criteria is based on the classification of the area in "risk area" through the program of monitoring "REPHY". (Ifremer)*
  
- ▶ *If **Dinophysis** and **Alexandrium** are responsible of the classification of the area in « risk area », a HHRA has to be done.*



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## Conclusions

To confer to decision criteria a protective character, **inflating hypotheses** have been considered.

Those values constitute decision criteria which conduce port authorities to assess or not the human health risk. **They have not to be considered as management thresholds.**

For HHRA, **local parameters** have to be preferred to theoretical values in order to reduce uncertainties.

**Mitigation measures** that can follow the highlighting of a health risk must be proportioned with identified stakes and some result's uncertainty.



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**Thanks**  
**for your attention.**

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