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Methodology for the optimization of waste management resulting from the clean-up of contaminated sites

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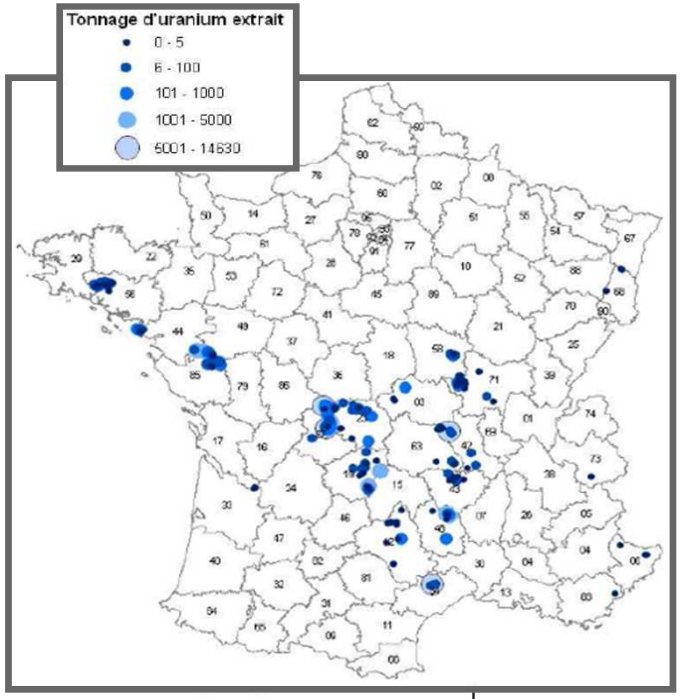
Plan

- Issue regarding the management of Low Level radioactive waste in France
- Assessment criteria for remediation options
  - Principles for contaminated sites remediation
  - Principles for nuclear sites
- Assessment criteria for remediation options – ongoing discussions
- Proposal for the implementation of these new methodological approaches



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Issue regarding the management of Low Level radioactive waste in France

- France has a very large nuclear industry covering all nuclear fuel cycle activities and generating substantial amounts of radioactive waste
  - Dismantling and remediation of nuclear facilities : (NPP, military sites ….)→ major operators : AREVA, EDF, CEA
  - Contaminated sites : industrial sites or legacy sites (contaminated by radium)-> (under state responsibility for most of them)

Issue regarding the management of Low Level radioactive waste in France

- Very Low Level Waste (VLLW) Dedicated disposal facility since 2003 Storage capacity : 650,000 m3 ~ 30 years of operation:
- Forecasts (excluding polluted sites and soils) : amount of waste VLLW should indeed be
  - 1,300,000 m^{-3} in 2030 ;
  - 1,900,000 m^{-3} at the end of dismantling of nuclear power plants

➢ total volume of VLLW produced would be at least 3 times the capacity of this disposal facility (saturation for 2020-2025)

Opening of a new disposal facility could raise major societal concern

➢ Necessary to investigate other methodologies in order to optimize the production of waste from the clean-up operations at these sites

Assessment criteria for remediation options - introduction

- Several methodological documents have been developed for the management and remediation of contaminated sites, mining sites or nuclear sites

  - the approaches for evaluating the radiological and chemical impact and site monitoring refer to the guide for the management of sites and soils potentially contaminated by radioactive substances

  - the requirements in terms of remediation objectives may vary to some extent for these two types of activities

Assessment criteria for remediation options - introduction

Any exposure on site ?

If exposure

If no exposure

assess the compatibility of the exposure (existing or planned) with the contamination level

no compatible with pollution

Remediation plan (exposure compatible with future uses)

Total withdrawal of pollution (reference option)

Cost benefits analysis

Alternative remediation option (< 1mSv)

Cost benefits analysis

Control of the uses, suveillance

Assessment criteria for remediation options - principles for contaminated sites remediation

- Principles and ongoing reflexion → dose constraints ?

  In case of sites with no currently exposure ;

  - **Primary goal = withdrawal of the totality of the source of pollution**
  - if the site operator plan remediation with the aim to make it compatible with all plausible uses
  - a management plan must be established to eliminate or reduce the added exposure with the aim to make possible a set of plausible future uses of the site and to avoid the control of the uses (restrictions or interdiction of the uses) ;

Introduction of the concept of constraint is intended to emphasize an optimization approach of the management solution

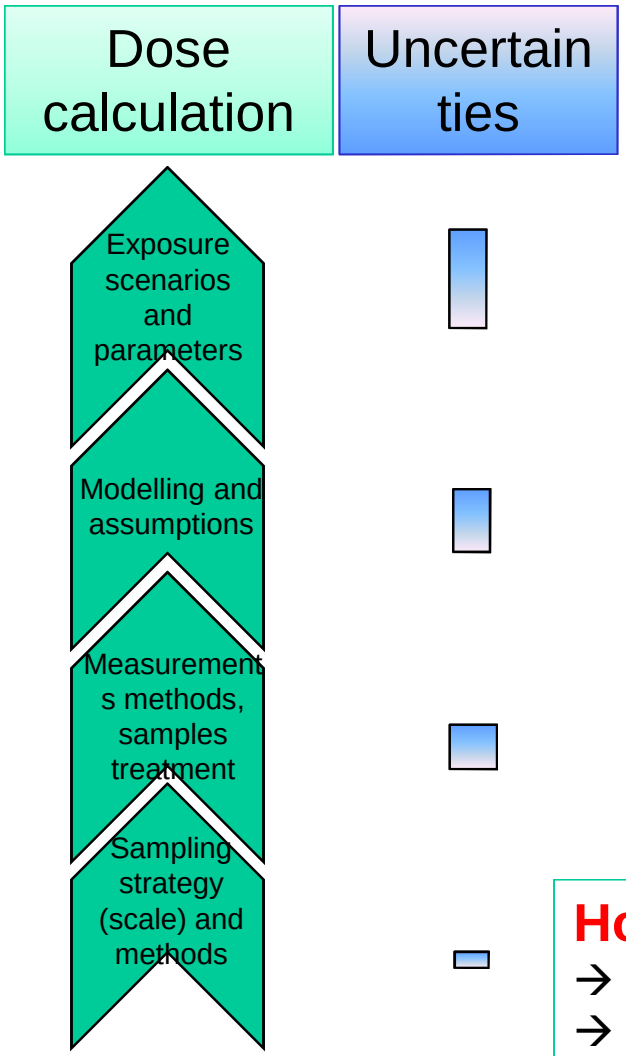
Assessment criteria for remediation options - principles recommended for nuclear sites

- Principles recommended for nuclear sites
  - **Primary goal = withdrawal of the totality of the source of pollution** → objective : achieve a “state of reference”
  - In case of difficulties for implemented this goal
    - Achievement of an “**in depth remediation**” →objective: “*achieving sufficient clean up (soil/structure) so as to make possible all plausible future uses of the site.”*
  - If “**in depth remediation**” does not comply with the requirements associated with “all plausible future uses of the site” →cost benefit analysis (process cleanup has been completed as far as reasonably possible, under conditions techno-economic acceptable)→**control of the uses envisaged**

Assessment criteria for remediation options - ongoing discussions

- Discussions are currently under way to merge these two approaches
  - ensure consistency of treatment of different cases (avoid a case-by-case judgment),
  - be sure that the remediation objectives (dose constraints for example or “in depth remediation”) can be matched.
  - promoting a graded approach to the cleanup of radiological contamination (thorough decontamination grows, control of uses), and which, taking into account the specificity of cases which may be encountered.
  - ➢ necessity to supplement the existing methodological approaches by more precise methodological elements.

Assessment criteria for remediation options - ongoing discussions



1 mSv

0,25 mSv

? mSv

0 mSv

Control of the uses

Cost benefits analysis

Dose constraint = In depth remediation ?

make possible all plausible future uses of the site

Cost benefits analysis

Total withdrawal of pollution

→ *state **of** reference*

How to be sure that 0,25mSv # 1 ???

→ Need to reduce the uncertainties

→ necessity to supplement the existing methodological approach

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Proposal for the implementation of these new methodological approaches

Methodological work to be engaged :

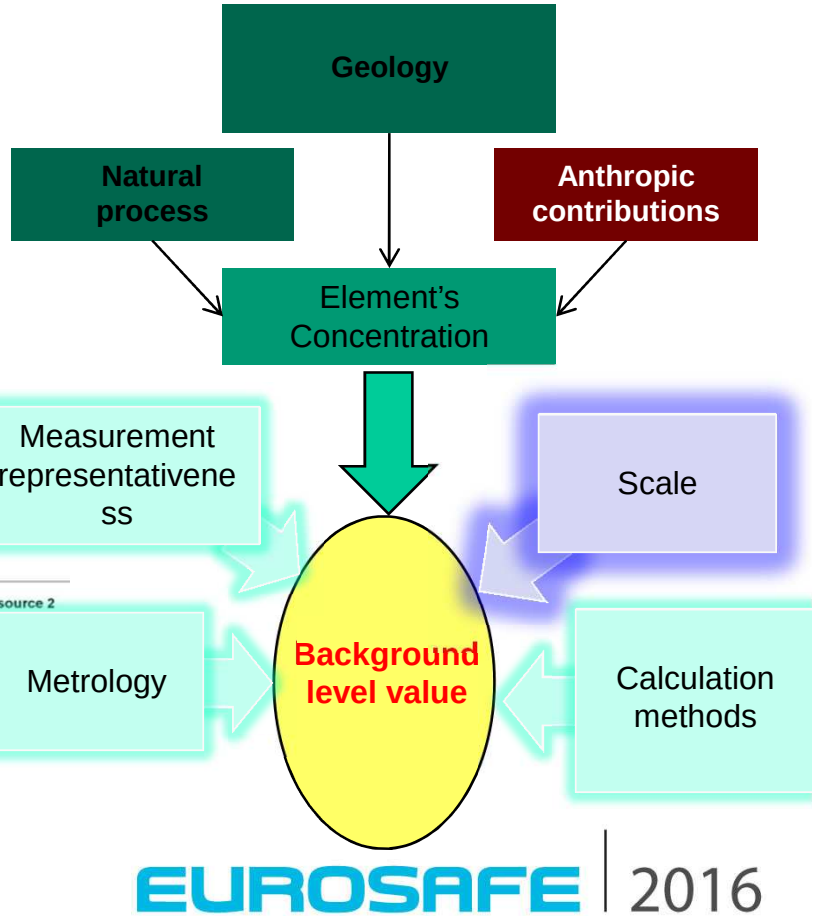
- **Methodology of characterization of the radiological background level (sampling strategy)** → comparison of the characterization of the site with the characterization of the surrounding soil presenting similar geological and geochemical characteristics
- **Characterization methods of pollution (**sampling and measurement) **to be applied to different categories of sites** →ensure a reliable estimate of this activity.

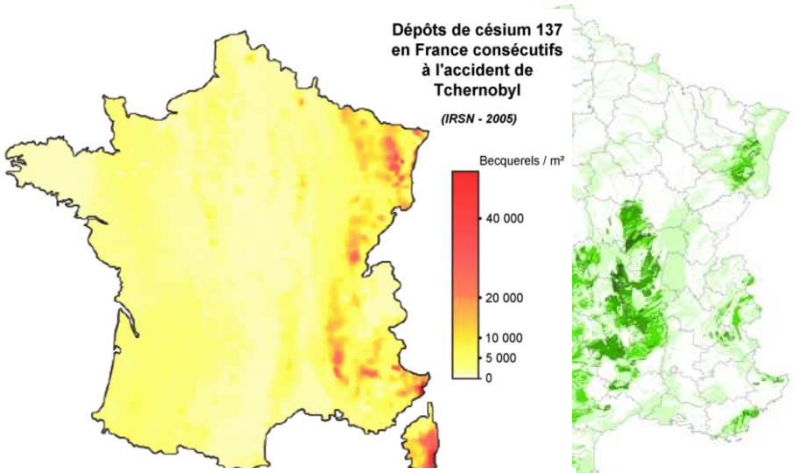
➢ reduce as far as possible the uncertainties associated with the estimation of the volumes of contamination.

Proposal for the implementation of these new methodological approaches

- **Definition of a "background level"** : *Natural and anthropic background ? ; Ambiant and strongly anthropic background ? ; Ambiant background ?; Natural background ……..*
- *What are the paramaters controlling*

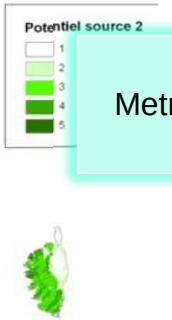
Parameters controlling the background level





Reconstitution of 137Cs deposit from Chernobyl accident in France

:oncentration



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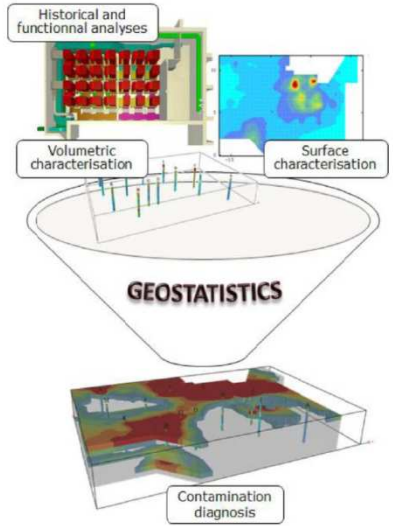
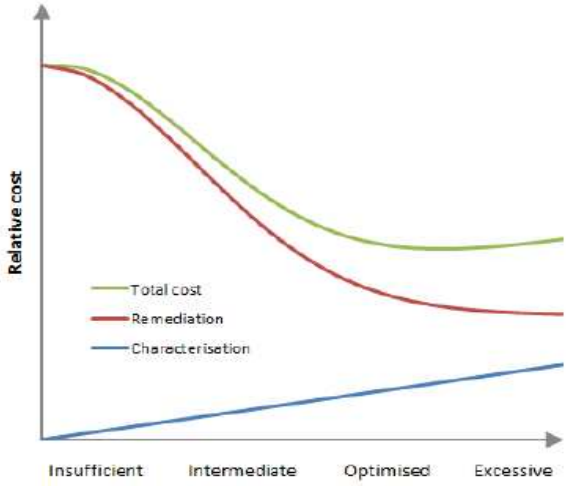
Proposal for the implementation of these new methodological approaches

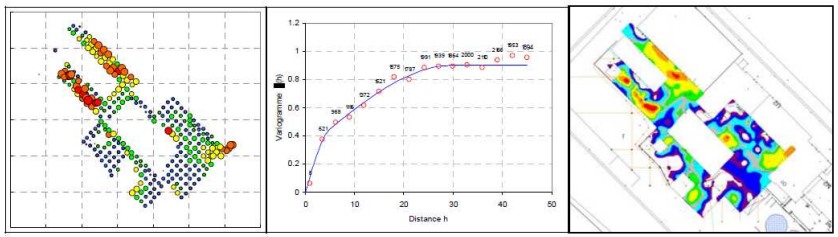
- **Methodology of characterization** Sampling strategy : background level / pollution (before/after remediation) characterization :
  - Statistical and geostatistical methods for a better spatial characterization: PESCAR methodology, Wilks formula, MARSSIM procedures ……
  - Optimisation of the sampling strategy
  - Contribution to the cost-benefits analysis



Geostatistic characterisation of a concrete slab (Iso/DIS 18557:2016)



Relevance of the characterization efforts as regards the total cost of the remediation project



Figures 3, 4 & 5 : Localisation des mesures (à gauche), variogramme expérimental et modélisation (au centre), cartographie obtenue par krigeage (à droite)

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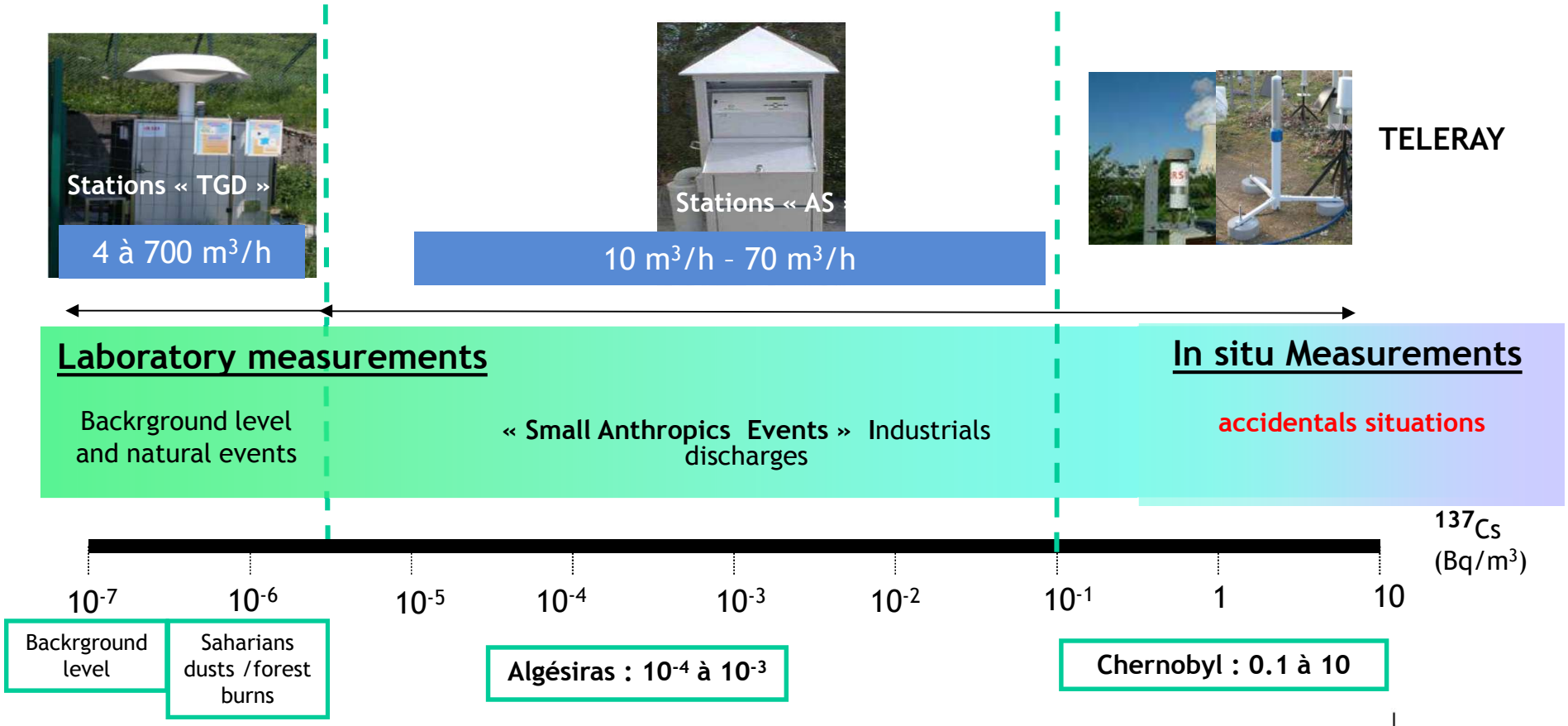
Proposal for the implementation of these new methodological approaches

- **Use the best available measurements techniques** →example of 137Cs in the atmosphere



Proposal for the implementation of these new methodological approaches

- Need to complete the existing guides with methodological elements to make the demonstration, that the residual impact of sites after remediation is sufficiently low to be considered compatible, in with all plausible use of the site.

➢ defining the key elements (characterization data, exposure scenarios, choice of assumptions reasonably penalising...).

  – ensure the robustness of the assessment of the residual impact

  – assess whether an additional remediation effort would be justified.

Define a reference value for chemical and radiological exposures as a « minimum» remediation goal to achieve

Conclusions

- Whatever the methodology chosen for the optimization of waste management resulting from the clean-up of contaminated sites
- Considering the importance of associated societal challenges regarding the problem of radiological waste management.

➢ **involvement of civil society in the definition and the implementation of these methodologies is the key point for the acceptance of the remediation process.**

Thank you for your attention !