

**ONDRAF/NIRAS**

# Monitoring strategies for radioactive waste disposal

The case of Geological Disposal

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# Outline

- What's new since 2013 (18th E.M.)?
- From the law to the strategy
- Role of repository monitoring in a safety case
- High-level strategy elements: strengths and weaknesses
- Examples (of strategies) from abroad
- Belgium?
- Conclusions

# What's new since 2013 ?

## w.r.t « monitoring » of GDF

- **EU project MoDeRn 2020**
  - ❑ WP 2 : monitoring programme design basis, monitoring strategies and decision making
  
- **Belgian law of 3<sup>rd</sup> June 2014 (2011/70/Euratom)**  
**Art.4 :**
  - ❑ « The national policies [...] will contain:
    - modalities of reversibility, retrievability and monitoring for RW disposal;
    - for a period to be determined [...];
    - the modalities taking due account of the safety of the disposal system »

# From the law to the strategy.

## Meaning of modalities ?

- **Modalities may refer to several questions:**
  - What ?  
Packages/elements of EBS/ host rock will be monitored ?
  - Where ?  
In situ or in a pilot facility ?
  - When ?  
before operation or/and during w. emplacement or/and after closure ?
  - (How ?)
    - refer to the means, tools and instrumentation
    - beyond the scope of WP2 (strategy)
    - beyond the scope of national policy !!

# From the law to the strategy

## Monitoring strategy for disposal?

- **Strategy** = plan/approach for successfully achieving a specified objective
  - **Monitoring strategy** = high-level approach to repository monitoring including consideration of *what; where and when*.
  - **The development of a monitoring strategy is important**
    - To comply with law and/or;
    - To initiate policies
- ...But first of all, to define the role of monitoring in the Safety Case  
(= high-level approach)

# Role of monitoring in a safety case

## Key messages

- **Reminder/ Monitoring definition (IAEA, SSG-31, 2014):**

« **Monitoring** refers to **continuous or periodic observations and measurements** to help **evaluate the behaviour of components** of a waste disposal system and **the impact of the waste disposal system** on the public and the environment. Most specifically, it covers the measurement of **radiological, environmental and engineering** parameters »

MoDeRn2020 adds to the definition:

- or **other** parameters/characteristics/indicators
- **In order to support decision making** during disposal process and **to enhance confidence** in the disposal process

# Role of monitoring in a safety case

## Key messages

- **Demonstration of safety does not/ should not rely on monitoring...**
  - ... but the « monitoring programme should be used to strengthen the safety case and to build confidence in safety »;
  - ... and one of the objectives of monitoring is to « verify that the disposal system is performing as expected, as set out in the safety case » (IAEA, SSG-31).

## Ambiguity ?!

→ **Monitoring outcomes must be used in the correct context**

# Role of monitoring in a safety case

## Key messages

- **Monitoring results cannot be (directly) compared to safety assessment model results. Why ?**
  - Safety assessment is based on the performance of barriers /SFs NOT a detailed evolution of system;
  - Safety assessment models use conservative/pessimistic assumptions and do not address all sub-system behaviour
  - Monitoring results can only be compared with models of (sub-)system evolution predicting parameters that are monitored  
(« History matching »)



# Role of monitoring in a safety case

## Key messages

↔ IAEA : « To verify that the **key assumptions** made and models used to assess safety are **consistent** with actual conditions » (IAEA, SSG-31)

↔ requirement for kind of « calibration »

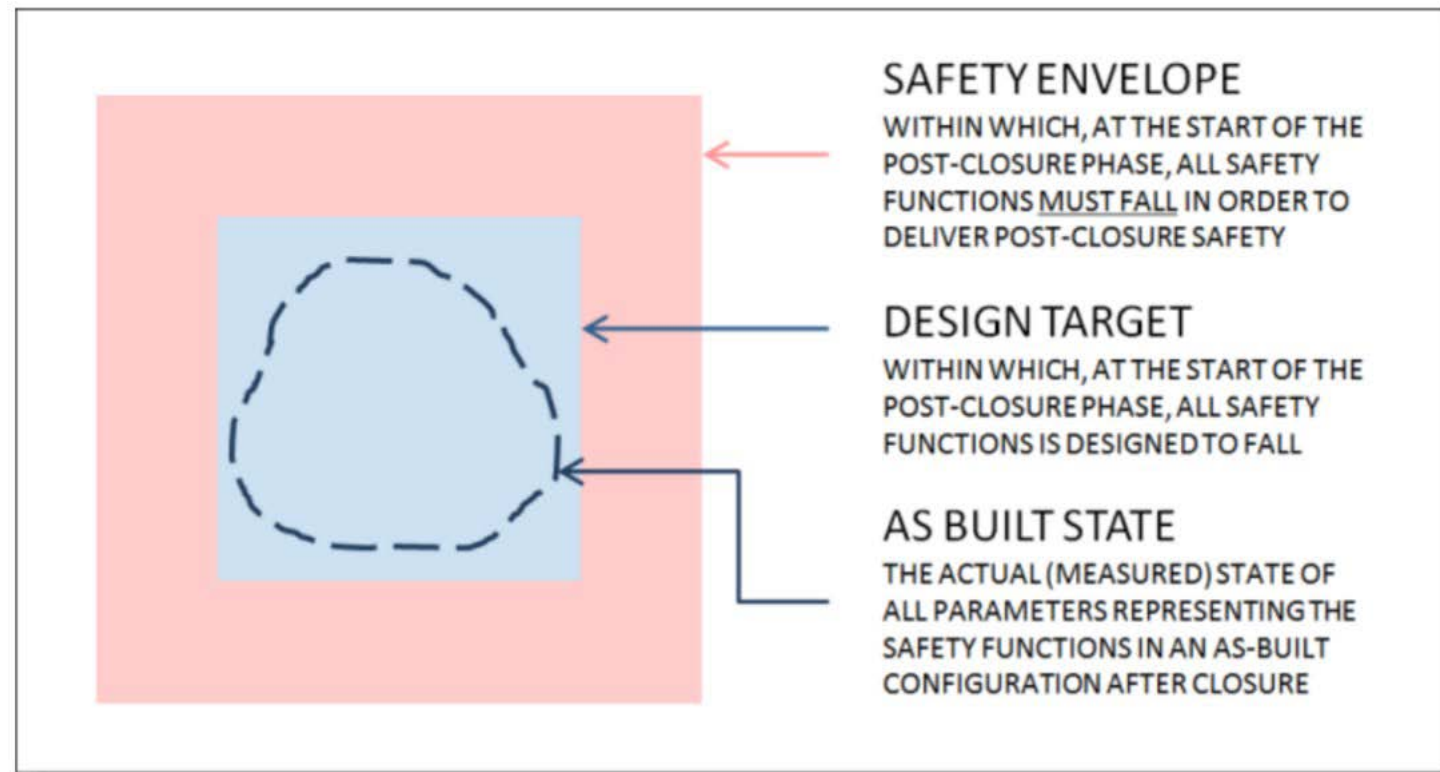
In short,

such monitoring results can be compared with the arguments made in a safety case to check whether the repository system is evolving in a way that has already been demonstrated to be safe.

# Role of monitoring in a safety case

## Key messages

- IAEA GEOSAF I & II developed an inspiring theoretical framework:



# Role of monitoring in a safety case

## Key messages

- Monitoring might be undertaken as part of verifying compliance with design requirements
- **Monitoring can be used** to check features of the repository evolution **to provide additional confidence in performance**

BUT

Should be designed so as **not to reduce the *overall* level of safety** of the facility after closure (**IAEA, SSR-5, 2011**)

# Role of monitoring in a safety case

## Key messages

**In reality, monitoring might affect the performance of the multi-barrier system (MoDeRn2020, D2.1)...acknowledged as an outstanding issue :**

« Is it better to know what's happening and accept a decrease in performance OR maintaining fully intact barriers and not know what is happening? »  
(MoDeRn2020)

**→ The extent to which monitoring affects performance should be addressed by monitoring strategy (MoDeRn2020)**

# Role of monitoring in a safety case

## Key messages

- **Monitoring may be required to address regulators requirements or public concerns**
  - ↔ to demonstrate compliance with regulatory requirements (...)
  - ↔ to provide information for the public (IAEA, SSG-31)
- **Monitoring can provide the principal input for the periodic updates of the safety case**
- **Monitoring can provide information for R&R during operational period**

# High-level strategy elements

## Where, what, when

| Where ?        | What ?             | When ?                   |
|----------------|--------------------|--------------------------|
| In situ        | Waste/EBS          | Before operation         |
| Pilot facility | Dummy packages/EBS | During waste emplacement |
| (URCF)         | Geological barrier | After closure            |

## Strengths and weaknesses

| ?              | Strengths  | Weaknesses                         |
|----------------|--|------------------------------------|
| In situ        | real repository conditions                             | wired systems may affect processes |
| Dummy packages | Sensors in the packages                                | THMC (B) : Ok<br>Radiological: NOK |
| After closure  | Provides confidence once waste/NF no longer accessible | Timeframe representative ?         |

e.g.

(excerpts of MoDeRn2020 analysis)

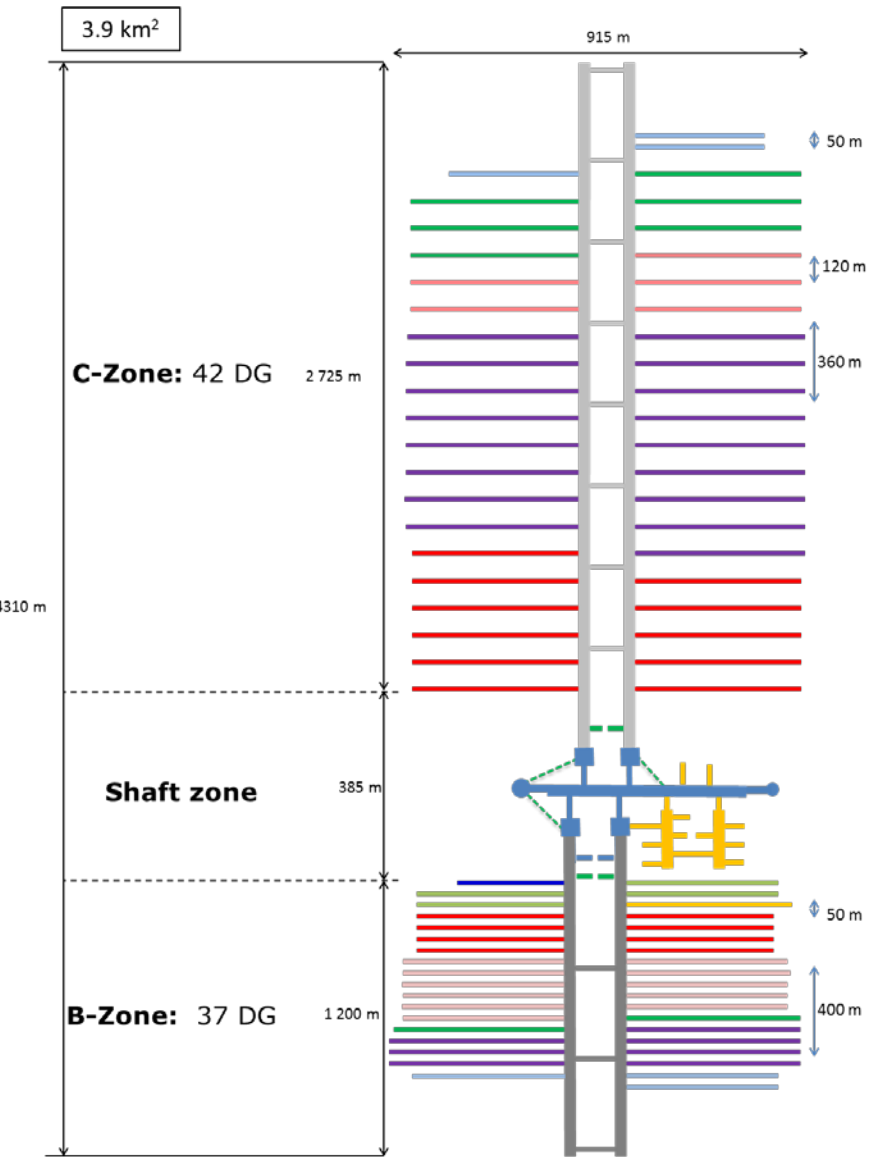
# Examples from abroad

## Strategies combining in ≠ ways what/where/when

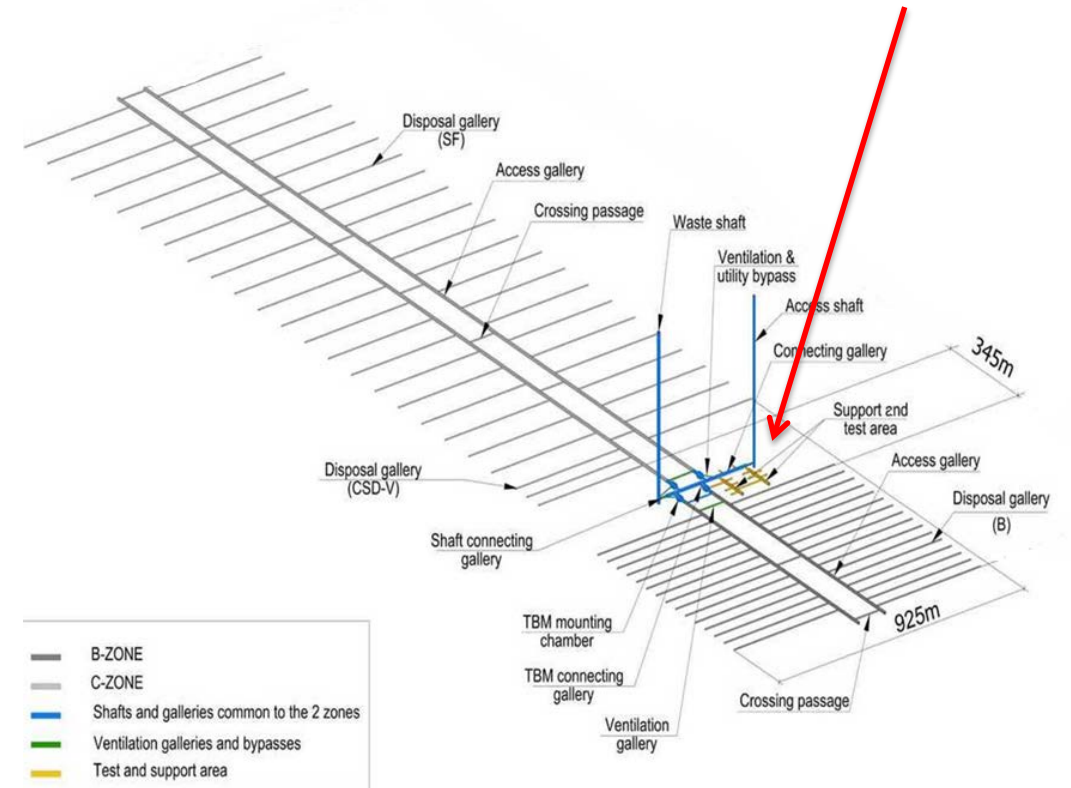
| ?     | ANDRA   | SKB/POSIVA   | NAGRA  |
|-------|---|--|--|
| Where | In situ   | In situ  | Pilot /UCRF  |
| What  | <b>Broad scope</b><br>Emplaced cells + EBS<br><b>Pilot facility</b> (with real waste)         | <b>Limited scope</b><br>Dummy packages + EBS (plugs)<br><br><b>UCRF</b>    | Real waste/EBS/Host rock (ENSI requirement)<br><br>Hydrogeology (UCRF) |
| When  | <b>Pilot:</b> Preliminary phase (10 years before operation)<br><b>Operational phase</b>       | <b>Operational phase</b>   | <b>Operational phase</b> until closure                                 |
| How   | Surveillance/current <b>structures</b> + standard disposal cells<br><br><b>Pilot facility</b> | URCF, in situ<br><b>NO monitoring of full waste/EBS</b> not to impair SF's | Not heavily instrumented<br><br>UCRF in situ without real waste        |

# Belgium ?

## Where / when ?



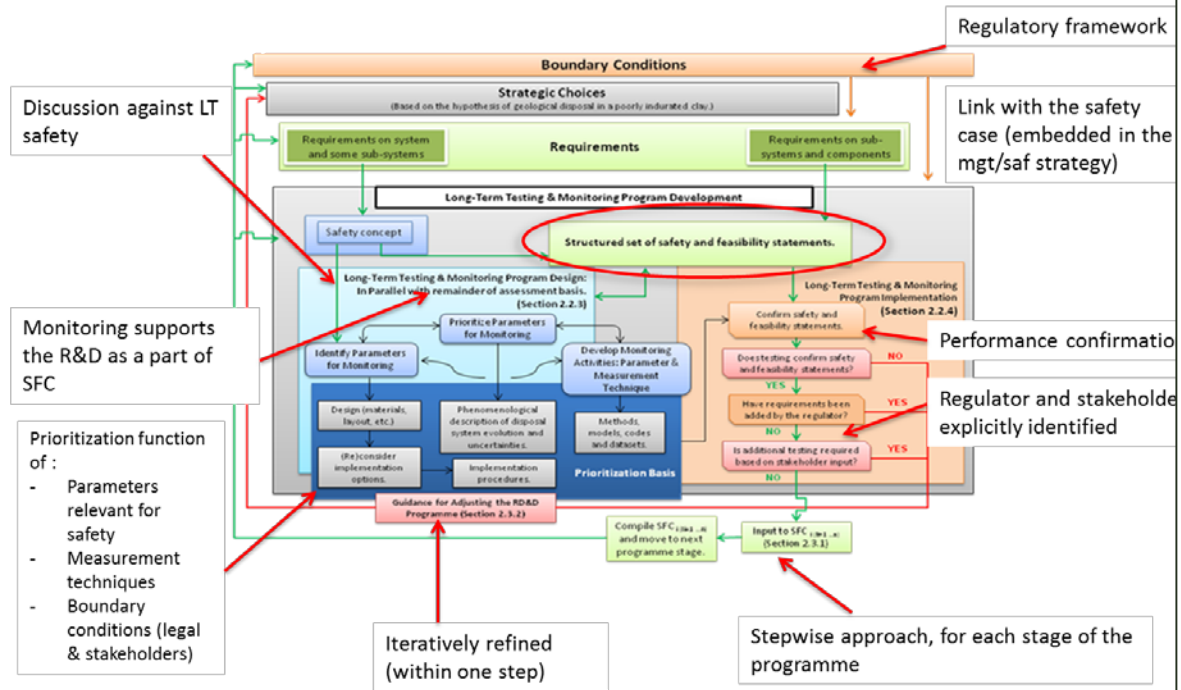
TEST area in situ



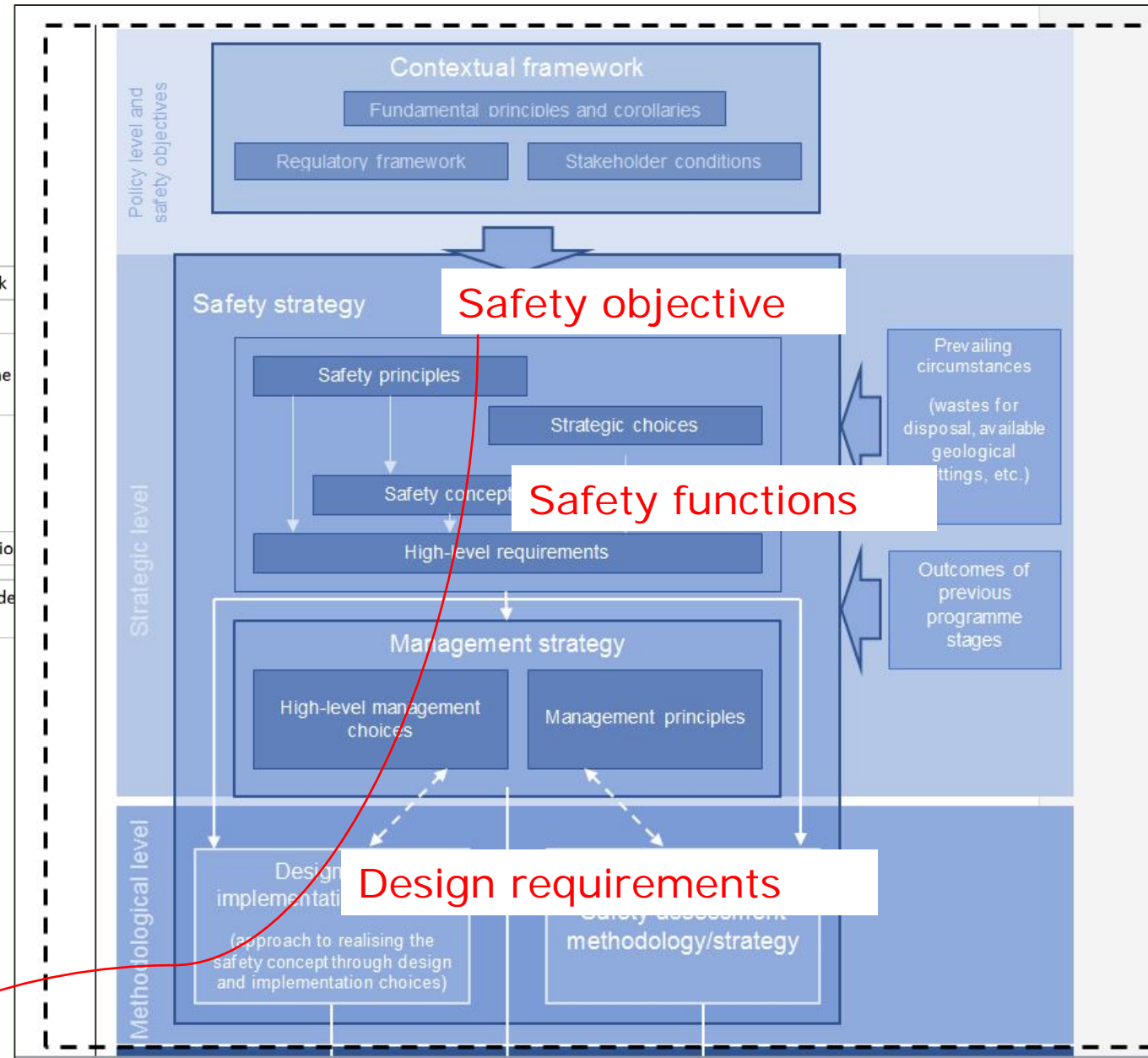
In parallel with the construction...



# Belgium ? What ?



Monitoring strategy such as presented in 2013



Vanessa's presentation (cAt)

# Belgium ?

## But seriously...

- Implementing such a strategy would require significant efforts and resources;
- But since 2013, there was another major change in the context (in addition to MoDeRn2020 and the law of transposition) :
  - **O/N was asked to investigate other potential host rocks than poorly indurated clays → The foreseen safety case can only be generic**
- Therefore, the focus shifted towards:
  - a watch of international monitoring programmes;
  - technological developments of monitoring techniques;
  - REX of monitoring in HADES → Jan Verstricht's presentation

# Conclusions

- Monitoring strategy is the high-level approach which addresses the questions what/where/when ( & how) to be monitored;
- Strategy frames the monitoring activities in order to comply with law and to address several concerns from the regulatory body, the public but also the scientific community and the implementers (≠ perspectives !?)
- Monitoring programmes can vary from country to country, ranging from broad to limited scope, from in situ to pilot or a combination thereof
- Degree of implementation of monitoring strategy seems to be strongly correlated to the national commitment towards GDF