Determining performance indicators for linking monitoring results and risk assessment

Application to the CO_2 storage pilot of Hontomìn, Spain

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Introduction

Risk management is an essential part of any industrial operation, and relevant for CO_2 injection and storage. Risk management is essential not only to ensure that there will be no detrimental impacts to public health or the environment, but also as a means to building trust in stakeholders. Operational risk management can be divided into three parts, namely: 1) risk assessment, where the risk is studied (this phase commonly involves numerical modelling); 2) monitoring during operations in order to check that the evolution of the site is in line with the pre-activity assessment; and 3) risk mitigation or risk treatment which includes any measure or action that can lower the risk either before or during operations. In the case of a CO_2 storage site, risk management activities also apply to the post-closure phase, until transfer of liability.

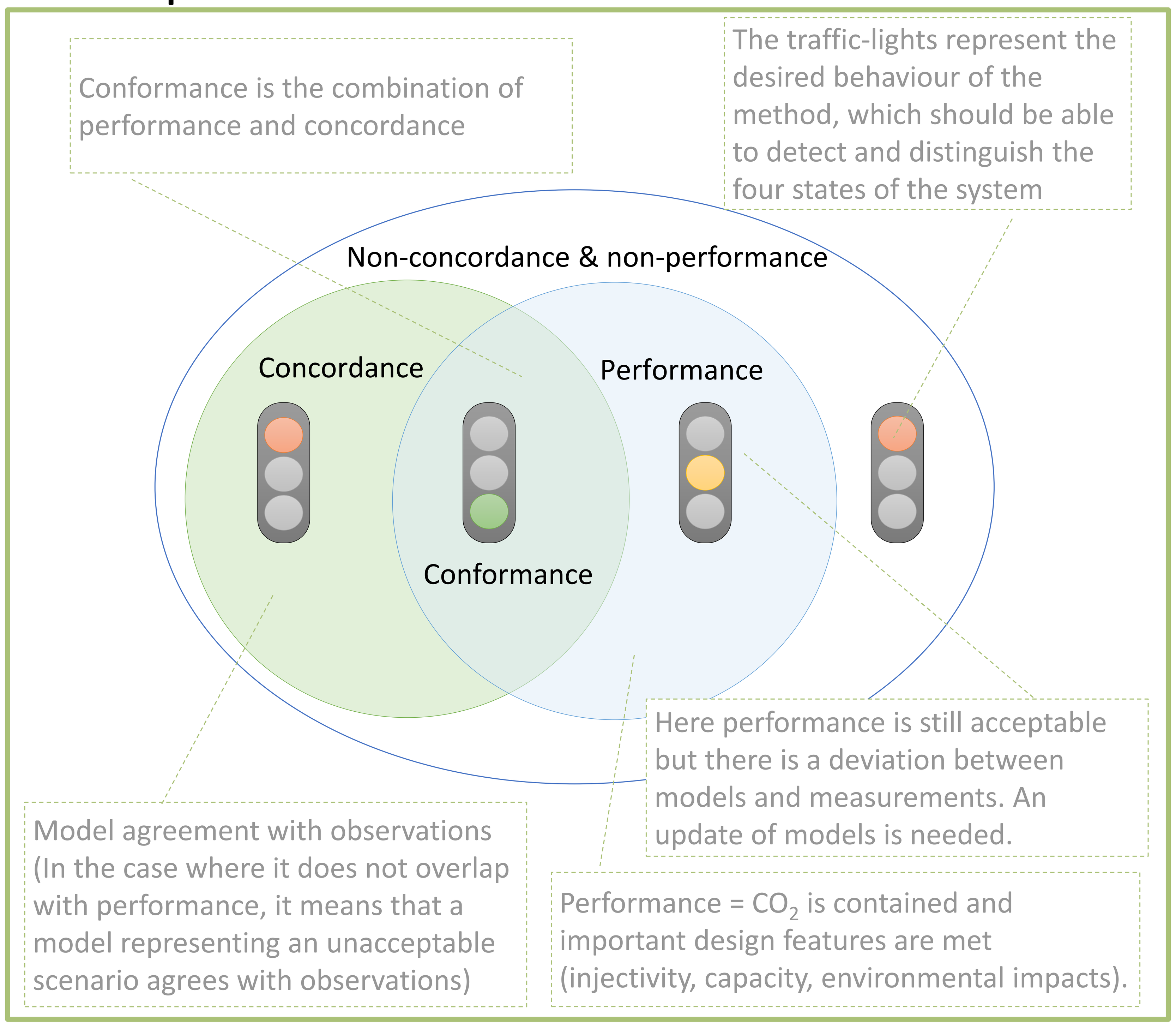
The goal of the ENOS project on this matter is to propose a method for a robust, integrated risk management system. More in particular, we focus on a method for determining indicators and thresholds for linking monitoring and risk assessment.

Preliminary thoughts

The idea is to expand to the other risks encountered in the analysed activity, the principle of **traffic-light systems** used for mitigating induced seismicity.

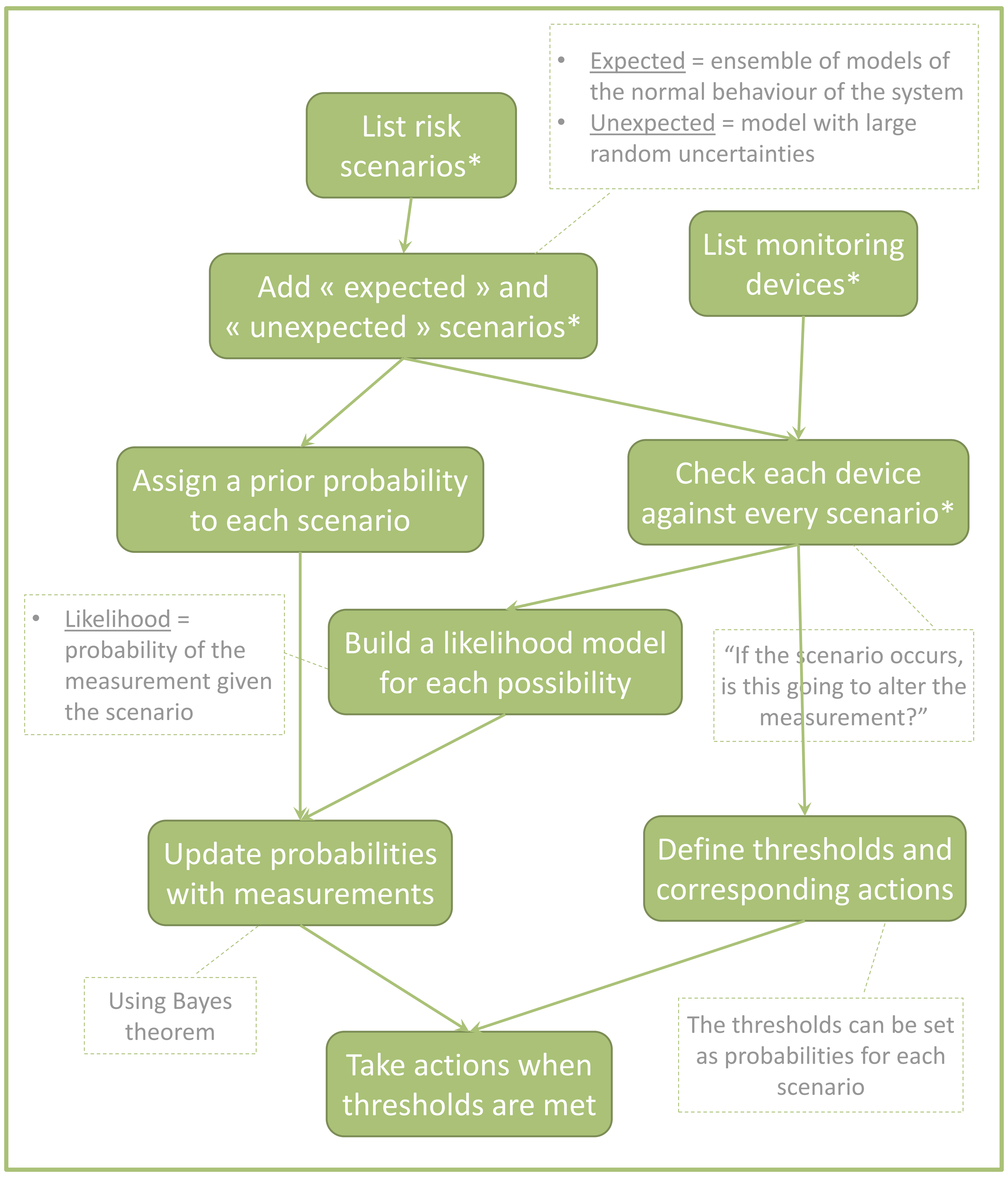
One of the main challenge is to build a method that can take account of **various measurements**, and of specific purposes of different monitoring approaches. In particular, the monitoring results will be used to check that **both performance and concordance** (i.e., agreement between measurements and models) are acceptable.

Concepts and features



Definition of the four states of the storage system and corresponding criteria; adapted and expanded from Oldenburg (2018)

Method



Overall method used for defining indicators and linking monitoring, risk assessment and risk treatment. The starred boxes are presented in this poster for the Hontomìn site.

Application to the Hontomìn site

The Hontomìn site is an onshore pilot of CO_2 injection and storage, located in Spain

As a preliminary step, for the site of Hontomin, the following risk scenarios are considered:

- LWHX: Leak through one of the six wells penetrating the reservoir (X={I;A;1;2;3;4})
- LF: Leak through potential existing faults
- LFC: Leakage due to fracturing of the caprock
- LPC: Leakage through the pore system of the caprock
- MB: Unwanted migration of brine into other formations
- IS: Induced seismicity

The list of the monitoring techniques that are deployed at the Hontomin site is the following:

- WHP : wellhead pressure (HI/HA wells)
- WHT: wellhead temperature(HI/HA wells)
- BHP: bottom hole pressure(HI/HA wells)
- BHT: bottom hole temperature(HI/HA wells)
- DTS: distributed temperature along HI well
- DAS: distributed acoustic system along HI well
- FM: Flow rate measurement (CO_2/Brine)
- MS: Microseismicity
- DS: Deep Sampling (HI well permanent, HA well portable)
- WL: Water level measurement in the hydrogeological wells (permanent/portable)
- WN: Water nature in the hydrogeological wells (permanent/portable)
- SG: Soil gas monitoring

	Normal	LW	LF	LFC	LPC	MB	IS	Unexpected
WHP	X	X						X
WHT	X	X						X
BHP	X	X	X	X	X	X	X	X
BHT	X	X	X	X	X			X
DTS	X	X						X
DAS	X	X						X
FM	X						X	X
MS	X						X	X
DS	X							X
WL	X	X	X	X	X	X		X
WN	X	X	X	X	X	X		X
SG	X	X	X	X	X			X

Risk/monitoring matrix, showing what monitoring device should respond to a scenario

Conclusion and perspectives

A lot of steps remain to be tested on real-life application and thus the method can still evolve.

Main challenges:

- Lots of modelling needed => re-use risk assessment work + identify more efficient process by testing various options
- Setting the thresholds, guaranteeing a "good" rate of false and missed alarms => possibility to use loss models + discussions with competent authorities
- Uncertain parameters => possibility to use Bayes for parameters update and not only for models

Main benefits of the method:

- Provide short-term prediction by comparing different pre-defined model and selecting the more probable given the data
- Able to distinguish the four states of the storage system (conformance, concordance only, performance only, and none)
- Work with different configurations:
  - Measurements evolving with injection or not
  - Measurements needing a transformation (e.g. inversion)
  - Combination of measurements

Full bibliography and more details in the accompanying paper!

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