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COMMENT



## Reflection on 'risk analysis and uncertainty: what does this mean for the Dutch energy transition' by Frederic Bouder and Ragnar Lofstedt

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### ABSTRACT

A general trend in the use of the Dutch deep subsurface is a shift from hydrocarbon production to geothermal energy production and subsurface storage of CO<sub>2</sub> and H<sub>2</sub>. A broad mistrust by the general public, and many local governments, of any deep-subsurface-related activity leads to an increasing tendency to block any development that might potentially cause harm to humans or the environment. A complicating factor in this respect is the uncertainty surrounding new technology and the lack of related historical data (notably seismic records). We support the opinion of Bouder and Lofstedt (2024) that to effectively address this problem, we should avoid a dichotomy of acceptable versus unacceptable risks, as stimulated by the use of the precautionary principle. Instead, we should use a Tolerability Of Risk (TOR) approach with the As Low As Reasonably Practicable (ALARP) principle as key element.

### KEYWORDS

Risk; uncertainty; subsurface; acceptance; tolerability; ALARP

We reflect on the paper by Bouder and Lofstedt (2024) from the perspective of energy professionals, both with around 40 years of industrial and academic experience, involved in the 'Mining Council' which advises the Dutch Minister of Economic Affairs on permit applications for exploration and exploitation of deep-subsurface resources. Over the past decades, these applications mainly focussed on hydrocarbons with occasional instances of rock salt production and deep waste-water disposal. Nowadays they are increasingly concerned with geothermal energy, while we foresee a growing number of permit applications for subsurface storage of natural gas, carbon dioxide or hydrogen. With a legal basis in the Dutch Mining Law, the Mining Council aims to provide a broad perspective on these permit applications, taking into account the formal advice from a wide number of governmental and professional organisations including the Dutch Regulator (State Supervision of Mines), Local and Provincial Governments, and Water Boards.

A general trend in moving from hydrocarbon-focused permits to those for energy transition-related ones, is a shift from market organization of a commercial activity with broadly accepted societal benefits, to balancing technical aspects (containment, subsidence, induced seismicity) with societal concerns that show an increasing focus on hazards and a (seemingly?) shrinking acceptance of risk. In this respect, a traumatic experience at national scale has been the development of induced seismicity in the huge Groningen natural gas field. In production since the early 1960s, the field started to show signs of induced seismicity

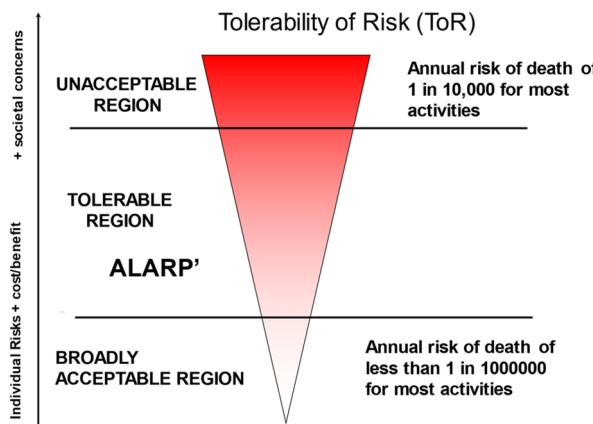


Figure 1. The tolerability of risk model (HSE 1989, 1992; 2000).

since the late 1980s, which, however, were only taken serious after an unexpectedly strong event in 2012. This lead to a dramatic sequence of late, inadequate or contradictory responses by industry and government, involving (lack of) repair of damaged buildings, an incomplete strengthening process of potentially unsafe ones, early overconservative seismic risk estimates, late production restrictions, and serious societal concerns, anxiety and unrest, finally resulting in an early closure of the field in 2024. A direct result of this debacle is a broad mistrust by the general public, and many local governments, of *any* deep subsurface related activity and an increasing tendency to block any development that might potentially cause harm to humans or the environment. A complicating factor in this respect is the uncertainty surrounding new technology and the lack of related historical data (notably seismic records). Moreover, the concept of harm is nowadays increasingly understood to also involve psycho-social aspects and not just physical ones.

In this light, the paper by Bouder and Lofstedt (henceforth referred to as 'the authors') is most timely. It starts by describing the increasing use of the 'precautionary principle' which guides decision makers to prohibit any subsurface activity of which harmful effects cannot be excluded a-priori, irrespective of the (quantified) risk. Unfortunately, this increasing risk avoidance slows down, or even blocks, the development of subsurface solutions in support of the urgently needed transition from fossil fuels to more sustainable energy sources. Referring to various definitions and concepts of risk and uncertainty, the authors state that uncertainty analysis should be an integral part of risk analysis. To do so effectively, they advocate to step away from a strict devise between 'acceptable' and 'unacceptable' risk, but, instead, to create a 'middle ground' by adopting the Tolerability of Risk (TOR) framework as illustrated in Figure 1 (which is based on work by the UK Health And Safety Executive in the 1980s). A key aspect of this framework is the use of the 'As Low As Reasonably Practicable (ALARP)' principle to guide decision makers in the management of those activities that are neither completely societally unacceptable, nor broadly accepted to be 'harmless'. The ALARP principle would then allow them to balance the tolerance of a certain amount of risk of an activity with its foreseen societal benefits (in a broad sense).

To effectively use such a TOR framework, the authors state three requirements:

1. A commitment to an approach that seeks to balance the 'time, effort and money' spent on safety (i.e. a risk-based approach);
2. The existence of a consensual regulatory culture; and
3. Mechanisms for the inclusion of stakeholder views.

Interestingly, the authors state that the first requirement would necessitate a revision of traditional Dutch policy tradition, rooted in flood protection, which they claim has an 'inbuilt difficulty to take into account financial-economic aspects and other preferences ... into the risk analysis model'. This statement seems to overlook more recent developments in the Netherlands, especially in the field of flood protection, which provide an example of balancing economic aspects with protective measures. Regarding the second criterion, they are optimistic given the traditional consensus-based nature of the Dutch regulatory culture. However, as regards the third criterion they question whether current efforts to increase risk communication and citizen participation are going far enough.

In our perspective it is the third criterion that will be most difficult to address, especially when it comes to a balanced approach. Particular challenges are the development of ways to more directly distribute benefits of subsurface activities of national importance to local communities, and of a scientific basis to take into account psycho-social aspects in addition to physical aspects. Given our experience in the operational field, we would like to stress that in order to meet the above requirements, it is of paramount importance that the public is made aware of the difference between risk and uncertainty. Moreover, in our experience, another key aspect in obtaining support for the ALARP principle is a commitment of all involved parties to *continuous improvement*. Although mentioned by the authors, they seem to underestimate the mistrust that may be felt by societal parties when economic benefits are used as justification to apply the ALARP principle instead of the precautionary principle. At the same time it is our experience that individual citizens, when confronted with the choice between risk and reward, often exhibit a more balanced judgement. It will be essential to safeguard the temporary nature of any 'tolerated' risk, and to ensure that both industrial and governmental parties subscribe to a periodic review and publicly auditable process of re-evaluation of hazards, risks and rewards. As an aside, we note that the resulting adjustment should allow for both strengthening and relaxation of earlier measures.

In conclusion we support the authors' opinion that we should avoid a dichotomy of acceptable versus unacceptable risks, as stimulated by the use of the precautionary principle, and use a Tolerability Of Risk (TOR) approach instead with the As Low As Reasonably Practicable (ALARP) principle as key element. This would require the continued use of formal uncertainty quantification and risk management, supported by the development of new ways of public risk communication; redistribution of benefits to local communities; a scientifically supported and practically applicable framework to value psycho-social aspects; and a legal basis, as well as commitment from all industrial and government partners involved, to ensure continuous improvement.