

## Introduction

Stakeholder engagement is an important part of the governance of the emerging technologies. It can help to inform decision-making and collect perceptions, opinions, and attitudes towards a certain technology. Nanotechnology, including nanoremediation, has received much attention in recent years. The use of nanoparticles in remediation offers potentially significant environmental benefits but there are uncertainties regarding the associated risk. Nanoremediation is also a field where theoretical research is closely linked to practical application. Therefore, it is important to engage stakeholders in the discussions about this technology. NanoRem is an EU-supported project that focuses on facilitating practical, safe, economic and exploitable nanotechnology for *in situ* remediation of groundwater and soil. Here we discuss how stakeholder engagement was used in the context of the NanoRem project.

## Stakeholder engagement in NanoRem

The NanoRem project supported dialogue and engagement with various European and international stakeholders in order to explore the extent of any consensus about appropriate uses of nanoremediation, understand its environmental risk-benefit, market demand, and overall sustainability and stakeholder perceptions.

*“Producing better decisions through inclusion of all the relevant expertise”*

Substantive rationale for stakeholder engagement

NanoRem engaged in a variety of activities involving stakeholders. Besides two elicitation workshops held in Nottingham and Oslo, several special sessions and focus groups were organized during relevant conferences and meetings. All the events brought together regulatory, industry and academic experts and other stakeholders interested in nanoparticle-enhanced remediation. This presentation relates to opinions surveyed, which in a number of cases have now been addressed by the practical outcomes of the NanoRem project.



Special session at SustRem2014



Participants of the Oslo workshop

## Outcomes

The outcomes of the Nottingham expert elicitation workshop, supported with evidence from the literature, formed the basis for a simple and conservative protocol for use during NanoRem field trials to control the risk posed by NP deployment and to reassure regulators that trials would be safe. This qualitative risk assessment protocol will be updated once the results of the NanoRem field trials and other experiments are available.

The findings of the Oslo workshop were used to frame sustainability assessments for a NanoRem trial site in the Czech Republic and a potential deployment site in the UK.

The results of the scenario investigation emphasized that any improvement of the market uptake of nanoremediation in Europe by 2025 is closely linked to the existence of validated data on case studies – in particular if this information can be told as success stories. In addition, dialogue between the stakeholders (science – industry – policy – general public) is crucial.

## Risk

Risk is driven by:

**Transport**

**Fate**

**Toxicity**

Results of discussions

- nanoparticles were unlikely to penetrate into the aquifer more than a few metres from the point of injection and were likely to interact with the aquifer matrix, groundwater and each other to rapidly lose mobility.
- there is a potential for the NanoRem nanoparticles to be toxic, but they would be substantially less potent than nano-silver, widely used in consumer products
- possible risks arising from renegade nanoparticles should be addressed through the conceptual site model. This model should be developed for any site deploying nanoparticles. The risk assessment protocol will be updated once the results of the NanoRem field trials and other experiments are available.

### ‘renegade’ nanoparticles

Particles that are deliberately injected into the polluted groundwater, but either survive beyond the duration of the pollution or are transported out of the polluted area.

## Sustainability

There is a need for a broader perspective and more attention to the relationship between environmental, social and economic factors.

- there is little difference between nanoremediation and other technologies when the generic sustainability issues are considered.
- uncertainties in risks and benefits related to the use of nanoremediation technology are the most important factor that will influence its future development.

Other challenges:

- reduction of production costs
- increasing the lifetime of the product
- enhancement of the transport mobility of the particles in the subsurface,
- identification of possible synergies with other *in situ* remediation techniques
- establishing appropriate methods to determine the environmental fate of particles



Group discussion at the Oslo workshop

## Markets

### “scenario” approach

Giving insights into the diversity of factors that potentially influence the future development of the nanoremediation market system - including its institutional setting.

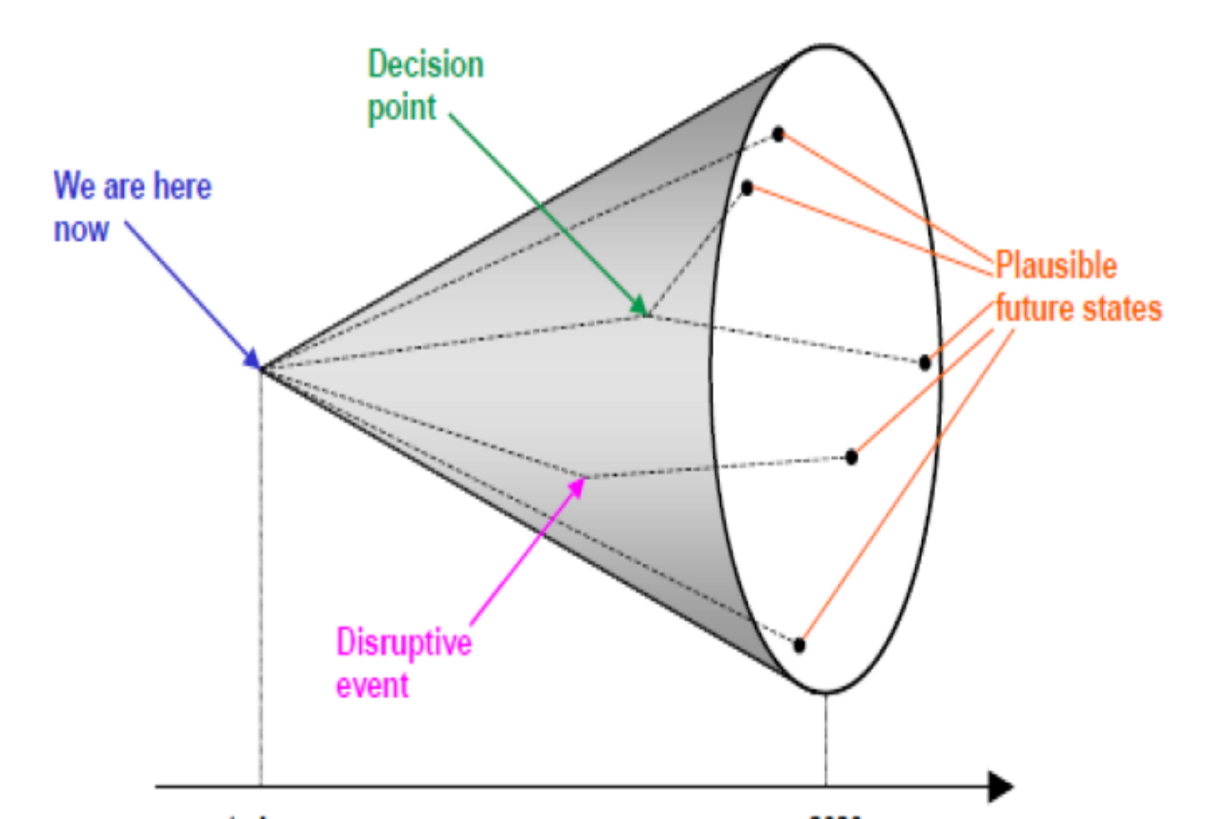


Figure 3.1 The scenario funnel  
Source: Timpe and Scheepers (2003)

The discussions identified and evaluated factors that are likely to drive or inhibit the development of the nanoremediation market and the relationship between them.

A factor can be active or passive depending on whether it is more likely to influence other factors or get influenced by them.

The most active factors that would be expected to determine development of the nanoremediation market:

- science-policy-interface
- availability of validated information on nanoparticle application potential.

