Uncertainty and Sensitivity Analysis of Environmental and Health Risks of Nanomaterials

Ensuring that EHS Research Prioritization and Efforts Transform into Short-term Decision-making Processes

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Uncertainty and Sensitivity Analysis of Environmental and Health Risks of Nanomaterials: Ensuring that EHS Research Prioritization and Efforts Transform into Short-term Decision-making Processes

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Scientific uncertainty about the environmental, health and safety issues (EHS) of nanomaterials has been recognized by scientists, regulators, NGO's as well as industry as a possible barrier towards nanotechnology reaching its full potential. Historically, research efforts tend to be directed towards specific, narrow scientific research questions with very limited perspective of reducing the overall uncertainty in the short-term, and hence they have had a limited prospect of facilitating informed risk-reducing decision-making processes. While it is important to investigate identified gaps within EHS knowledge and research for the sake of science itself, it is also crucial that these research efforts are strategically focused and prioritized in order to assist regulators, industry, as well as scientists in the EHS challenges that face them in developing nanomaterials. Therefore, this study investigates the main areas of uncertainty related to EHS of nanomaterials, as well as investigates the level, nature and sensitivity of the scientific uncertainty.

In this study the scientific uncertainty was systematically mapped by locating the areas of uncertainty through an in-depth analysis of government reports, scientific reviews and primary articles dealing with and/or investigating the potential risks of nanomaterials. Once the locations of uncertainty were identified, we assigned and discussed the level and the sensitivity of the uncertainty.

We found that significant knowledge gaps exist not only in terms of documenting potential (eco)toxicological effects, but also in terms of characterizing exposure and nanoparticles behaviour even in simple test systems. For example, uncertainty related to testing strategies and environmentally-realistic exposure scenarios, impedes a successful risk characterisation of engineered nanoparticles according to several reports. This includes establishing, developing and standardising reference materials, monitoring and detection equipment and estimating human and environmental exposure concentrations. These issues ultimately lead to significant challenges in performing human and environmental risk assessments and present a daunting task for regulators. We recommend that increased efforts are made by risk assessors and regulators to recognize the location of EHS uncertainties and to address the sensitivity of identified knowledge gaps while simultaneously ensuring that the "right" scientific questions are addressed. This is a prerequisite to effectively prioritise research resources to reduce uncertainty most pertinent to an accelerated risk analysis of nanomaterials.