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Broadening our view on nanomaterials: highlighting potentials to contribute to a sustainable materials management in preliminary assessments

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Apart from completely novel functionalities, the utilization of nanomaterials (NMs) holds great promise for increasing the performance and efficiency of products and processes. In doing so, they are also expected to be more sustainable in that they may allow for products and processes that can provide better services using less material and energy. However, whether or not NMs do in fact contribute sustainable development still remains a matter of debate. While a relatively high number of risk assessment studies have revealed some of the toxicological and ecotoxicological repercussions of NMs, other sustainability related issues have so far received comparatively little attention. One of these issues refers to the sustainability implications of material use, such as environmental impacts of materials supply, resource depletion, or material criticality. Here, we argue that an adequate assessment of NM-based innovations calls for an inclusion not only of human health and environmental risks but also of aspects related to sustainable materials management. Recognizing the inherent complexity of sustainability issues as well as the difficulties of meeting data needs in early innovation stages, we propose a prospective and preliminary framework to assess the potential benefits and risks of NM-based innovations. We demonstrate the framework's practicability and usefulness in decision-making contexts by applying it to four in-depth case studies of specific NM-based innovations. Also, we point to some methodological issues that may need consideration in the further improvement of the framework.

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