NanoFATE Deliverable 6.4

Phylogenetic and trait based analysis of effects across species and the range of ENPs used including discussion on applicability of the SSD approach

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Research Report Summary

A proper risk assessment of engineered nanoparticles (ENPs) in the environment requires assessment of a level that is safe to ecosystems. Usually, such a safe level, also indicated as Predicted No-Effect Concentration (PNEC), is derived from laboratory toxicity data, using either application factors (AF) or Species-Sensitivity Distributions (SSDs). Which method is applicable depends on the type and number of ecotoxicity data available and also on the representation of organisms indicative for the ecosystem to protect, e.g. aquatic (freshwater, marine) or terrestrial. This is the current approach for organic chemicals and metals.

The application of SSDs for the hazard characterization of ENPs poses two specific challenges. Firstly, an SSD is based on a comparative assessment of results from toxicity tests with different species. An SSD therefore always requires the comparison of results from different tests, i.e. from experimentations in different growth media and often of different duration. This, however, might have a profound impact on the dissolution, aggregation and agglomeration kinetics of the tested ENPs, which might confound an SSD. Secondly, it is still unclear whether the elementary composition of an ENP is the sole determinant for its toxicity, or whether (and to which extent) secondary characteristics (size, coating, etc.) are also of importance. It is therefore not yet fully clear which particle (sub)types can be compiled into one common SSD.

This deliverable explores the current practice of applying AF and SSDs, by taking into account the current developments in nano-toxicology and -ecotoxicology. It focuses first on the possible applicability of phylogenetic and trait-based approaches to assess whether the

battery of existing toxicity data is representative of the ecosystem that has to be protected. Next it discussed whether the metrics used for chemicals (usually mass-based concentrations) will also be applicable for ENPs. As such, this deliverable provides the basis for Deliverable D6.5, which will apply the SSD approach to data on the toxicity of ENPs to organisms from soil and water generated within NanoFATE and from the literature.

Within NanoFATE and in the literature only a few different test organisms have been used to assess the toxicity of ENPs. For the aquatic environment, the battery of commonly used test organisms is restricted to bacteria, algae, daphnids and fish. Within NanoFATE this battery has been extended by including mussels, which represents a marine organism, and a freshwater snail. For soil, most studies have been performed with earthworms followed by nematodes, springtails and isopods. As a common requirement is to base an SSD on a minimum of 8 different taxa, this might not be sufficient to apply an SSD approach. Further, it needs to be clarified to what extent related particles can be included within a single distribution rather of whether data needs to be treated distinct within separate risk assessments. Concerning metrics, it is recommended to compare or rank the sensitivities of different organisms upon expression of toxicity on the basis of different units, e.g. on mass, particle number, and surface area. If this will lead to great differences in the order of sensitivities, there is a need to further study the role of metrics. Estimation of PNECs for metal-based ENPs should always include assessing PNECs also for the corresponding free ion. These approaches may also help unravelling the importance of different routes of exposure of ENPs compared to free metal ions. It therefore is recommended to further explore all these aspects in Deliverable 6.5.

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