An integrated approach to assess the environmental risks of nanomaterials

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To date, headway has been made in exploring the potential impacts of engineered nanomaterials (ENMs) on human health. However, investigation of the roles of nano-scale objects towards evolutionary change, environmental disturbance, ecosystem structure and function have lagged behind the advances in fabricating, measuring and manipulating materials at the nano-scale. Moreover, current approaches to assess the ENMs environmental safety are based on classical ecotoxicology approaches, which are not always adequate for ENMs. For instance, most of the research only concerns the hazard but rarely the exposure to ENMs that plays a pivotal role to understand their environmental risks. The exposure depends on various properties; some of them are those of colloids (*e.g.* hetero-, homo-aggregation, adsorption of organic matter), while others are characteristic of nano-size (*e.g.* redox transformation, dissolution and ubiquist mineralogy).

We will present an innovative design offering physico-chemists, (micro)biologists, and ecologists the possibility of conceiving robust experiments to study the exposure and impacts of engineered nanomaterials as well as mechanistic concepts at various time and spatial scales. This system is based on modular, intermediate size indoor aquatic mesocosms. It is adjustable to several ecosystems as lotic, lentic, estuarine, or lagoon environments. This experimental design has been approved at the European level as a Standard Operational Procedure (SOP) to characterize the environmental exposure and impact of ENMS (**Auffan et al. 2014**).

Using CeO_2-, Ag-, and TiO_2-ENM examples, we will demonstrate that the physical-chemical conditions and their evolution during the 45 days experiment were reproducible between the 9 mesocosms. Two weeks were necessary to reach a state of equilibrium in the mesocosms in terms of pH, redox potential, number of colloidal particles, development of bacteria and algae, and microbial community composition. These examples will highlight that the exposure of the macro- and micro-organisms (benthic *vs.* planktonic) and the impacts were strongly related to the contamination scenario, and the (bio)distribution and (bio)transformation of the ENMs (**Tella et al. 2014, 2015**).

References: Auffan M et al. (2014) Scientific reports 4: 5608.
Tella M et al. (2014) Environmental Science & Technology 48: 9004-13.
Tella M et al. (2015) Environmental Science-Nano 2: 653-63.